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Aeronautical Engineering
A Continuing Bibliography with Indexes

NASA SP-7037(205)
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NASA SP-7037(205)

AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

(Supplement 205)

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced in September 1986 in

- *Scientific and Technical Aerospace Reports (STAR)*
- *International Aerospace Abstracts (IAA).*

NASA Scientific and Technical Information Branch 1986
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INTRODUCTION

This issue of *Aeronautical Engineering -- A Continuing Bibliography* (NASA SP-7037) lists 517 reports, journal articles and other documents originally announced in September 1986 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA).*

The coverage includes documents on the engineering and theoretical aspects of design, construction, evaluation, testing, operation, and performance of aircraft (including aircraft engines) and associated components, equipment, and systems. It also includes research and development in aerodynamics, aeronautics, and ground support equipment for aeronautical vehicles.

Each entry in the bibliography consists of a standard bibliographic citation accompanied in most cases by an abstract. The listing of the entries is arranged by the first nine *STAR* specific categories and the remaining *STAR* major categories. This arrangement offers the user the most advantageous breakdown for individual objectives. The citations include the original accession numbers from the respective announcement journals. The *IAA* items will precede the *STAR* items within each category

Seven indexes -- subject, personal author, corporate source, foreign technology, contract number, report number, and accession number -- are included.

An annual cummulative index will be published.

TABLE OF CONTENTS

TYPICAL REPORT CITATION AND ABSTRACT

NASA SPONSORED

ON MICROFICHE

ACCESSION NUMBER — **N86-10033*#** Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Chemistry. — CORPORATE SOURCE

TITLE — **A FUNDAMENTAL STUDY OF THE STICKING OF INSECT RESIDUES TO AIRCRAFT WINGS Annual Technical Report**

AUTHORS — N. S. EISS, JR., J. P. WIGHTMAN, D. R. GILLIAM, and E. J. SIOCHI Apr. 1985 191 p refs — PUBLICATION DATE

CONTRACT NUMBER — (Contract NAG1-300) — AVAILABILITY SOURCE

REPORT NUMBERS — (NASA-CR-176231; NAS 1.26:176231) Avail: NTIS HC A09/MF A01 CSCL 01C — PRICE CODE

COSATI CODE

The aircraft industry has long been concerned with the increase of drag on airplanes due to fouling of the wings by insects. The present research studied the effects of surface energy and surface roughness on the phenomenon of insect sticking. Aluminum plates of different roughnesses were coated with thin films of polymers with varying surface energies. The coated plates were attached to a custom jig and mounted on top of an automobile for insect collection. Contact angle measurements, X-ray photoelectron spectroscopy and specular reflectance infrared spectroscopy were used to characterize the surface before and after the insect impact experiments. Scanning electron microscopy showed the topography of insect residues on the exposed plates. Moments were calculated in order to find a correlation between the parameters studied and the amount of bugs collected on the plates. An effect of surface energy on the sticking of insect residues was demonstrated.

Author

TYPICAL JOURNAL ARTICLE CITATION AND ABSTRACT

NASA SPONSORED

ON MICROFICHE

ACCESSION NUMBER — **A86-11041*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

AERODYNAMIC DESIGN CONSIDERATIONS FOR EFFICIENT HIGH-LIFT SUPERSONIC WINGS — TITLE

AUTHOR — D. S. MILLER and R. M. WOOD (NASA, Langley Research Center, Hampton, VA) — AUTHOR'S AFFILIATION

CONFERENCE TITLE — AIAA, Applied Aerodynamics Conference, 3rd, Colorado Springs, CO, Oct. 14-16, 1985. 9 p. refs

(AIAA PAPER 85-4076) — CONFERENCE DATE

A previously developed technique for selecting a design space for efficient supersonic wings is reviewed; this design-space concept is expanded to include thickness and camber effects and is evaluated for cambered wings at high-lift conditions. The original design-space formulation was based on experimental upper-surface and lower-surface normal-force characteristics for flat, uncambered delta wings; it is shown that these general characteristics hold for various thickness distributions and for various amounts of leading-edge camber. The original design-space formulation was also based on the assumption that the combination of Mach number and leading-edge sweep which would produce an equal division of flat-wing lift between the upper and lower surface would also be the proper combination to give the best cambered-wing performance. Using drag-due-to-lift factor as a measure of performance, for high-lift conditions cambered-wing performance is shown to significantly increase as conditions approach the design space; this correlation is demonstrated for both subcritical and supercritical flows.

Author

AERONAUTICAL ENGINEERING

A Continuing Bibliography (Suppl. 205)

OCTOBER 1986

01

AERONAUTICS (GENERAL)

A86-38356
PILOT'S ASSOCIATE - WHAT SHOULD IT DO?
R. L. STROM (Rockwell International Corp., Pittsburgh, PA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 5 p.
(SAE PAPER 851890)

This paper describes the analysis required to select which crew decisions and actions should be assigned to an airborne computer system, capable of handling massive amounts of data and accomplishing speeds of analysis, calculation, and decision beyond human capability. Such a system is referred to as a Pilot's Associate (PA). The required processing system would probably utilize a combination of Artificial Intelligence (AI) concepts and deterministic algorithms. To determine what functions must be accomplished by the combination of the aircraft crew and an expert system requires a top-down analysis of required functions, from which can be derived decision and action requirements, data processing requirements and allocations of performance between the PA and the crew. Author

A86-39567#
NEXT GENERATION AIRCRAFT STRUCTURES - THE NEED FOR CO-ORDINATED CANADIAN R & D PROGRAMS
J. THOMPSON (CASI, Structures and Materials Section, Ottawa, Canada) Canadian Aeronautics and Space Journal (ISSN 0008-2821), vol. 32, March 1986, p. 50-53.

The directions which Canadian R & D in aircraft structures are expected to take over the next 25 yr are discussed. Current programs are targeted at developing composite secondary structures which can be certified for regular use, particularly in the DHC-7 and DHC-8 aircraft. Near- and mid-term research will examine carbon-fiber, aramid, aramid/aluminum hybrids, aluminum lithium alloys, and powder metallurgy ingot aluminum alloys, mainly for commuter aircraft. The parts which will receive the most attention are wings and flaps, empennages, fuselages and flight control surfaces. The efforts will require the development of standardized analytical and numerical tools, NDE testing methods and test procedures, extensive material characterization studies, and funding and performance of components testing programs. It is notable that commuter aircraft primary structures will be required to be as resistant to impact damage from, e.g., birds, as typical modern larger passenger aircraft. M.S.K.

A86-39570#
COST-EFFECTIVE REMOTE-SITE TESTING
M. P. ROSEMEYER (De Havilland Aircraft of Canada, Ltd., Downsview) Canadian Aeronautics and Space Journal (ISSN 0008-2821), vol. 32, March 1986, p. 75-80.

The DASH-8 aircraft was flight-tested using short-term trials at remote sites in order to control testing costs and accelerate the test program. Additionally, data acquisition and analysis were performed using computers and instrumentation used with the DASH-7 aircraft, along with 10 new commercially-available microcomputers. The flight tests were distributed among two sites in Arizona and one in Michigan, with most test trips lasting shorter than 6 weeks, an interval regarded as optimum for a maximum sustained team effort. Cooperation was gained with the local ATC in order to coordinate the efforts with normal traffic patterns and to avoid any conflicts between required testing and ATC priorities. Short tabulations are provided of the man-hours, travel times, and test-time cost savings achieved while accomplishing the flight tests needed for certification. Finally, the success of efforts to design the DASH-8 right the first time are emphasized, since only three structural changes were identified as necessary and implemented during the development period. M.S.K.

N86-26277*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
SUMMARY OF RESULTS OF NASA F-15 FLIGHT RESEARCH PROGRAM
F. W. BURCHAM, JR., G. A. TRIPPENSEE, D. F. FISHER, and T. W. PUTNAM Apr. 1986 34 p refs Presented at the AIAA 3rd Flight Testing Conference, Las Vegas, Nevada, 2-4 Apr. 1986
(NASA-TM-86811; H-1341; NAS 1.15:86811; AIAA-86-9761)
Avail: NTIS HC A03/MF A01 CSCL 01B

NASA conducted a multidisciplinary flight research program on the F-15 airplane. The program began in 1976 when two preproduction airplanes were obtained from the U.S. Air Force. Major projects involved stability and control, handling qualities, propulsion, aerodynamics, propulsion controls, and integrated propulsion-flight controls. Several government agencies and aerospace contractors were involved. In excess of 330 flights were flown, and over 85 papers and reports were published. This document describes the overall program, the projects, and the key results. The F-15 was demonstrated to be an excellent flight research vehicle, producing high-quality results. Author

N86-26278# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
AEROSPACE KNOWLEDGE MAGAZINE (SELECTED ARTICLES)
X. LI, Z. WANG, and X. WU 15 Jan. 1986 19 p Transl. into ENGLISH from Hangkong Zhishi (China), no. 6, 1985 p 17-21
(AD-A164720; FTD-ID(RS)T-1008-85) Avail: NTIS HC A02/MF A01 CSCL 01C

This Chinese translation is of three articles from Aerospace Knowledge Magazine. The articles are Su-7 and Su-17 about the Soviet fighter bomber and the variable geometry swept-wing fighter bomber; Infrared Decoy about the scapegoat infrared countermeasure against infrared guided missiles. Smoke and flame decoys, composite decoys and fuel type decoys are also discussed in this article. The last article is entitled Distinguishing between several Soviet aircraft. GRA

N86-26279# Air Command and Staff Coll., Maxwell AFB, Ala.
WHAT USAF AIRCRAFT SHOULD BE THE WILD WEASEL OF THE 1990'S?: AN ASSESSMENT OF THE F-4G, THE F-15WW, AND F-16WW M.S. Thesis
M. J. NEITZEL 7 Jun. 1985 125 p
(AD-A164727) Avail: NTIS HC A06/MF A01 CSCL 01C

The USAF Wild Weasel mission was born in 1965 during the Vietnam conflict. The purpose of the mission was to counter the

serious radar-directed threats that were decimating the US fighter arsenal. While the current F-4G Wild Weasel aircraft has effectively met the threat into the 1980's, its capabilities reflect the aircraft's 1950's design. Meanwhile, the Soviet Union is fielding many technologically advanced radar-directed threats that bring the adequacy of the F-4G into question. This study investigated what characteristics will be required to defeat the threat of the 1990's. Next, the F-4G, F-15WW, and F-16 Wild Weasel proposal were compared against the aircraft characteristics needed (as determined by a poll of experienced officers) to survive the threats in the 1990's. This thesis concludes that the F-15WW possesses the most desirable characteristics to serve as the Wild Weasel aircraft for the 1990's. GRA

N86-26280# Army Command and General Staff Coll., Fort Leavenworth, Kansas.
THE C-17: AN ATTEMPT AT INCREASED AIRLIFT VERSATILITY M.S. Thesis
J. W. STONE 7 Jun. 1985 127 p
(AD-A164822) Avail: NTIS HC A07/MF A01 CSCL 01C

The Airlift Master Plan was developed as a guide for achieving long-term military airlift objectives. The cornerstone of the plan is the development and acquisition of the C-17. Although the C-17's direct-delivery concept is new, the quest for expanded aircraft versatility has been continually pursued in previous airlift aircraft development programs. Thus the C-17 is not the first aircraft that has attempted to combine the traditionally separate roles of intertheater and intratheater airlift. The most recent attempt at developing an aircraft capable of meeting both strategic and tactical requirements resulted in the C-5A. The C-5A failed to achieve the operational versatility predicted by its proponents and that failure has given rise to serious questions in regard to the C-17's probability of success in realizing its expanded airlift goals. A comparison of the C-5A and C-17 programs revealed the differences in concept formulation, design and acquisition strategy which will allow the C-17 to achieve its operational goals. The study further concludes that the direct-delivery concept is a valid airlift objective and current technology permits the development of an aircraft with the performance capabilities necessary to fulfill that objective. GRA

N86-26281# Air Force Academy, Colo.
AIR FORCE ACADEMY AERONAUTICS DIGEST Final Report
J. H. RUSSELL and M. HALE Sep. 1985 85 p
(AD-A164940; USAFA-TR-85-11) Avail: NTIS HC A05/MF A01 CSCL 05I

This Digest covers unclassified research in aeronautics by individuals assigned to or associated with the United States Air Force Academy. Partial contents: Aerodynamics - Unsteady forces acting on a flat plate airfoil undergoing chord deformation, and Unsteady surface pressure measurements on a pitching airfoil; and Engineering Education - Undergraduate airbreathing propulsion at the US Air Force Academy, and How to fairly account for an excused exam. GRA

N86-26282# Naval Postgraduate School, Monterey, Calif.
AN ANALYSIS OF S-3 SDLM (STANDARD DEPOT LEVEL MAINTENANCE) CORROSION DOCUMENTATION PROCEDURES M.S. Thesis
S. L. HANSON and M. E. KARR Dec. 1985 77 p
(AD-A165588; NPS554-85-011) Avail: NTIS HC A05/MF A01 CSCL 05A

When senior personnel in Naval aviation are asked the question, How much time and money are we spending on corrosion prevention and correction?, fairly accurate estimates can be obtained for the organizational and intermediate levels of maintenance because they break out these costs in their maintenance data reporting systems. It is virtually impossible to quantify these same costs at the depot level since their current reporting system will not allow for the collection of such information. A second problem, caused by this rather limited reporting system, concerns the inability of the depot level engineering staff to gather sufficient accurate information about the types, extent, and locations of corrosion that occur on aircraft. This report provides a system design and implementation plan for corrosion monitoring for the Naval Air Rework Facility at Alameda, California. A computerized system for corrosion data collection and processing is needed. Research in this area led to the Depot Maintenance Data System (DMDS). GRA

N86-26283*# Notre Dame Univ., Ind. Dept. of Aerospace and Mechanical Engineering.
PROCEEDINGS OF THE CONFERENCE ON LOW REYNOLDS NUMBER AIRFOIL AERODYNAMICS
T. J. MUELLER, ed. Jun. 1985 356 p refs
(Contract NASA ORDER L-77177-B; N00014-85-G-0123)
(NASA-CR-177308; NAS 1.26:177308; AD-A163609; UNDAS-CP-77B123) Avail: NTIS HC A16/MF A01 CSCL 01B

Current interest in a variety of low Reynolds number applications has focused attention on the design and evaluation of efficient airfoil sections at chord Reynolds numbers from about 100,000 to about 1,000,000. These applications include remotely piloted vehicles (RPVs) at high altitudes, sailplanes, ultra-light man-carrying/man powered aircraft, mini-RPVs at low altitudes and wind turbines/propellers. Although the design and evaluation techniques for airfoil sections above chord Reynolds numbers of 500,000 are reasonably well developed problems related to boundary layer separation and transition have made it difficult to extend these techniques to lower Reynolds numbers. Presently available design and analysis techniques require improved criteria for laminar separation transition, reattachment and turbulent separation. Mathematical models of these complex phenomena require additional very careful experimental studies. GRA

N86-27178# Minority Services, Inc., Washington, D.C.
MICROWAVE LANDING SYSTEM (MLS) STATION INTERFACE CONTROL REPORT
Jun. 1986 182 p
(Contract DTFA01-86-Y-01010)
(DOT/FAA/PM-86/17) Avail: NTIS HC A09/MF A01

This report contains requirements which are applicable to the MLS Interfaces for the system control functions, Remote Monitoring and Maintenance System status and maintenance reporting functions, and the synchronization function. The purpose is to provide for complete interoperability of MLS ground equipments which may have a different design and/or manufacturer, serving opposite ends of the same runway. Information is provided for the communication protocol and message/data formats between the Maintenance Processor Subsystem (MPS) and the Remote Monitoring System (RMS) of an MLS. The Remote Control and Status Unit (RCSU) is the RMS focal point for the MLS. Similar information is provided for the interface/communications between the RCSU and the stations of the MLS. A Printer/Terminal (P/T) provides active interface with the MLS stations. Information on the P/T interface and the set of P/T commands is provided. The various operating/non operating states of the MLS are given. A set of data parameters is given which may be transmitted to the MPS as descriptors of the MLS operating status history, site related parameters, monitor related parameters and maintenance related parameters. Parameter information is provided for the intra-system synchronization function. Author

N86-27179# Grand Canyon National Park, Ariz. Resources Management and Planning Div.
AIRCRAFT INFORMATION PACKET (GRAND CANYON NATIONAL PARK, ARIZONA)
Sep. 1985 53 p
(PB86-159704; GCNP/AIR/INFO-85/1) Avail: NTIS HC A04/MF A01 CSCL 01B

The Aircraft Information Packet presents an overview of the aircraft overflight issue at Grand Canyon National Park which was made available for public review in September 1985. The packet consists of a task directive and pre-planning booklet distributed for public review and comment from September 17, 1985 through December 17, 1985. The task directive provides a background of the aircraft issue at Grand Canyon, the legal and policy constraints under which the management plan is being developed, a summary

of research to date, and a discussion of the planning process being followed. The pre-planning booklet provides an overview of current aircraft use, a summary of public involvement to date, and an analysis of possible mitigation actions being considered to address this issue. GRA

02

AERODYNAMICS

Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces; and internal flow in ducts and turbomachinery.

A86-37192* Ohio State Univ., Columbus.
INVESTIGATIONS OF TRANSONIC TRAILING EDGE FLOWS
S. L. PETRIE and D. S. EMMER (Ohio State University, Columbus, OH) IN: Aerospace simulation II; Proceedings of the Second Conference, San Diego, CA, January 23-25, 1986 . San Diego, CA, Society for Computer Simulation, 1986, p. 199-210. refs
(Contract NSG-2298)

An experimental study of several of the trailing edge and wake turbulence properties for a NACA 64A010 airfoil section was completed. The experiments were conducted at the Ohio State University Aeronautical and Astronautical Research Laboratory in the 6 inch x 22 inch transonic wind tunnel facility. The data were obtained at a free stream Mach number of 0.80 and a flow Reynolds number (based on chord length) of 5 million. The principal diagnostic tool was a dual-component laser Doppler velocimeter. The experimental data included surface static pressures, chordwise and vertical mean velocities, RMS turbulence intensities, local flow angles, and a determination of turbulence kinetic energy in the wake at chordwise locations. between the transonic shock wave and the trailing edge, in the near wake just downstream of the trailing edge and in the far wake. At the two angles of attack tested (0 and 2 degrees), the turbulence intensities and turbulence kinetic energy were observed to decay in the streamwise direction. In the far wake, for the non-lifting case, the turbulence intensities were nearly isotropic. For the two degree case, the horizontal component of the turbulence intensity was observed to be substantially higher than the vertical component. Author

A86-37196#
AERODYNAMIC CHARACTERISTICS OF A CIRCULATION CONTROLLED SYMMETRICAL AIRFOIL WITH DUAL JET
K. KUWABARA, K. TSUBOI, H. OKAMOTO, Y. TOMINAGA, and M. YASUHARA Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 34, no. 386, 1986, p. 125-133. In Japanese, with abstract in English. refs

The effects of two blowing jets on the aerodynamic characteristics of a 20 percent thick, noncambered airfoil are described. The free stream wind tunnel velocity is 10 m/s and the Reynolds number is 1.7 x 10 to the 5th. Section lift, drag and pitching moment coefficients are given at various effective angles of attack. The position of the second slot has a strong effect on the characteristics and the highest lift to drag ratio is given at 55 deg from the first one. A two-jet system is found to be more effective in producing high lift than a one-jet system at the same jet-power coefficient. Author

A86-37769* Army Aviation Systems Command, Moffett Field, Calif.
CALCULATION OF HELICOPTER AIRFOIL CHARACTERISTICS FOR HIGH TIP-SPEED APPLICATIONS
W. J. MCCROSKEY, J. D. BAEDER (U.S. Army, Aeroflightdynamics Directorate, Moffett Field, CA), and J. O. BRIDGEMAN (NASA, Ames Research Center, Moffett Field, CA) American Helicopter Society, Journal (ISSN 0002-8711), vol. 31, April 1986, p. 3-9. Previously announced in STAR as N86-18294. refs

In this paper, we have applied a new aerodynamic tool to the study of helicopter airfoil characteristics. We have shown that the computed airloads reproduce completely the experimental behavior of representative airfoils across the transonic regime. In addition, the computational details of the flow fields, the surface pressure distributions, and the viscous-layer characteristics enable us to trace the evolution of the physical changes that occur as m infinity or Re increases. Descriptions of the complicated development of shock waves, shock-induced separation supplement the information that has been obtained heretofore in wind tunnels. In validating our calculations and assessing the accuracy of the results, including extensive grid-refinement studies and comparisons with data from numerous wind tunnels, we have defined the capabilities and limitations of the code ARC2D more precisely. This important aspect of the investigations can complement wind-tunnel tests, by providing flow-field details that are difficult to measure and by extending the range of low parameters beyond the capabilities of existing wind tunnels. The code has now progressed from a purely research stage to almost a production stage, where it can be run by specialists in the helicopter industry. GRA

A86-37801
APPLIED AERODYNAMICS CONFERENCE, 4TH, SAN DIEGO, CA, JUNE 9-11, 1986, TECHNICAL PAPERS
Conference sponsored by AIAA. New York, American Institute of Aeronautics and Astronautics, 1986, 446 p. For individual items see A86-37802 to A86-37850.

Papers are presented on unsteady transonic flows past airfoils using the Euler equations, an analysis of elliptic grid generation techniques using an implicit Euler solver, wing-wing interference effects for cruciform missiles, stability of side forces on bodies at high angles of attack, and wind tunnel test of a model rotor with a free tip. Consideration is given to viscous-inviscid analysis of transonic and low Reynolds number airfoils, effect of Karman vortex shedding on airfoil stall flutter, a two-dimensional transonic aerodynamic design method, unsteady forces on counter-rotating propeller blades, and flow structure of lateral wing-tip blowing. Additional papers include a high order supersonic triplet singularity, coupling between vehicle motion and slender cone transition, wing and conical body of arbitrary cross-section combinations in supersonic flow, influence of forebody cross-sectional shape on wing vortex burst location, and improved computation of the transonic flow on high-lift devices. I.S.

A86-37802*# North Carolina State Univ., Raleigh.
UNSTEADY TRANSONIC FLOWS PAST AIRFOILS USING THE EULER EQUATIONS
G. E. SMITH, H. A. HASSAN (North Carolina State University, Raleigh), and W. WHITLOW, JR. (NASA, Langley Research Center, Hampton, VA) IN: Applied Aerodynamics Conference, 4th, San Diego, CA, June 9-11, 1986, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1986, p. 1-9. refs
(Contract NGT-34-002-800)
(AIAA PAPER 86-1764)

An explicit finite difference solver for the Euler equations was developed and used to calculate the flow past two of the AGARD standard aeroelastic configurations, an NACA 64A010 and an NLR 7301. The algorithm employed uses a modified four step Runge-Kutta time stepping scheme, boundary conditions determined from the time-dependent theory of characteristics and an unsteady automatic grid generation procedure. In general, the calculated results are in good agreement with available experiment. Moreover, they demonstrate the importance of using the Euler equations for super-critical airfoils and in situations where the transonic small disturbance theory results in poor agreement with experiment. Author

A86-37803#
EULER CALCULATION FOR FLOW OVER A WING IN GROUND EFFECT
J. E. DEESE and R. K. AGARWAL (McDonnell Douglas Research Laboratories, St. Louis, MO) IN: Applied Aerodynamics Conference, 4th, San Diego, CA, June 9-11, 1986, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1986, p. 10-15. Research sponsored by the McDonnell Douglas Independent Research and Development Center. refs
(AIAA PAPER 86-1765)

An Euler solver based on the finite-volume Runge-Kutta time-stepping scheme has been developed to predict the flow around airfoils and wings in ground effect. The technique is applied to a Clark Y-airfoil and a low-aspect-ratio wing (Clark Y-airfoil section) in subsonic flow. Results are compared with experimental data and PANAIR (panel method code) calculations. Author

A86-37804#
AN ANALYSIS OF ELLIPTIC GRID GENERATION TECHNIQUES USING AN IMPLICIT EULER SOLVER
J. S. MOUNTS, A. MARTINEZ (USAF, Armament Laboratory, Eglin AFB, FL), and J. F. THOMPSON (Mississippi State University, Mississippi State) IN: Applied Aerodynamics Conference, 4th, San Diego, CA, June 9-11, 1986, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1986, p. 16-26. refs
(AIAA PAPER 86-1766)

Several control function interpolation techniques in a general three-dimensional elliptic grid generation code and their effects on flow solutions using an implicit Euler algorithm are examined. These results will serve to guide the design of control function procedures and interpolation techniques in general grid generation codes. Three configurations and three grid types ('O', 'C', and 'H' grids) are examined. The results indicate that the selection of the control function interpolation techniques, which affects grid spacing, should be based on boundary curvature and spacing. The selection of the interpolation technique can then be made transparent to the user of general grid generation codes. Author

A86-37805#
EULER SOLUTIONS FOR AIRCRAFT CONFIGURATIONS EMPLOYING UPPER SURFACE BLOWING (USB)
E. ATTA, S. RAGAB, and L. BIRCKELBAW (Lockheed-Georgia Co., Marietta) IN: Applied Aerodynamics Conference, 4th, San Diego, CA, June 9-11, 1986, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1986, p. 27-35. refs
(AIAA PAPER 86-1767)

A method has been developed for calculating the flowfield around complex aircraft configurations using upper-surface blowing (USB). The method is based on a zonal grid generation approach coupled with an Euler flow solver algorithm. In this method the flowfield is divided into a number of non-overlapped regions, each containing a component of the aircraft such as a wing, a fuselage or a nacelle. H-type grids are generated independently in each region using a hybrid elliptic/algebraic grid generation scheme. An explicit finite volume Euler algorithm has been developed that is applicable to the multi-region H-type grids. The present method has been applied to a two-dimensional USB model and a realistic aircraft configuration consisting of a wing/fuselage with two integrated nacelles. Numerical results indicate that the computational method is effective in predicting the flowfield about USB-type configurations and complex aircraft geometries. Author

A86-37806*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
COMBINED, NONLINEAR AERODYNAMIC AND STRUCTURAL METHOD FOR THE AEROELASTIC DESIGN OF A THREE-DIMENSIONAL WING IN SUPERSONIC FLOW
J. L. PITTMAN and G. L. GILES (NASA, Langley Research Center, Hampton, VA) IN: Applied Aerodynamics Conference, 4th, San Diego, CA, June 9-11, 1986, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1986, p. 36-44. refs
(AIAA PAPER 86-1769)

An iterative procedure for the static aeroelastic design of a flexible wing at supersonic speeds has been developed. The procedure combines a nonlinear, full-potential solver (NCOREL) with an equivalent plate structural analysis method. The NCOREL method yields significantly improved aerodynamic estimates compared to linear theory. The equivalent plate structural analysis method demonstrates an order of magnitude reduction in computer memory and execution time compared to finite-element methods. A highly swept wing is analyzed at high lift using this aeroelastic procedure. The results indicate that the wing deforms favorably due to aerodynamic loading and, consequently, that the inviscid drag levels do not vary at the required lift coefficient although the angle of attack varies significantly. A sensitivity analysis of the type required for optimization studies was also performed with the aeroelastic design procedure. Author

A86-37809#
VORTEX-INDUCED BENDING OSCILLATION OF A SWEPT WING
L. E. ERICSSON (Lockheed Missiles and Space Co., Inc., Sunnyvale, CA) IN: Applied Aerodynamics Conference, 4th, San Diego, CA, June 9-11, 1986, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1986, p. 62-71. refs
(AIAA PAPER 86-1773)

An analysis of existing experimental results shows conclusively that the observed bending oscillations of a highly swept wing can not have been caused by the induced effects of a single leading edge vortex but are caused by the interaction between two leading edge vortices, one generated by a thick inner wing or wing-body glove and the other by the outboard, thin, variable sweep wing. This inner-outer wing vortex interaction is similar to that occurring on a double-delta planform wing. The cause of the negative aerodynamic damping from the vortex-interaction is the sensitivity to angle of attack and its time derivative of the spanwise location of a leading edge vortex. Author

A86-37811#
AN INVESTIGATION OF IMPROVING HIGH ANGLE OF ATTACK PERFORMANCE AND FLAP EFFECTIVENESS OF A CONFIGURATION WITH DELTA WING BY SPANWISE BLOWING
L. SHEN and Y. QIN (China Aerodynamic Research and Development Centre, Mianyang, People's Republic of China) IN: Applied Aerodynamics Conference, 4th, San Diego, CA, June 9-11, 1986, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1986, p. 79-85. refs
(AIAA PAPER 86-1777)

The paper presents an investigation conducted in a 1.4 by 1.4-m wind tunnel and an 0.4 by 0.4-m water tunnel, respectively, to determine the improvement of high angle-of-attack performance and flap effectiveness of a 60-deg delta wing configuration by spanwise blowing at wing and trailing edge flaps, respectively. The data obtained in the wind tunnel shows that spanwise blowing at the wing results in much more vortex-induced lift with blowing at rearward chordwise locations than near the leading edge at high angles of attack. Spanwise blowing at trailing edge flap induces a significant improvement to the flap effectiveness over the entire angle-of-attack range tested. Water tunnel flow visualization shows that the nozzle chordwise location has significant effects on the vortex pattern over the wing at high angle-of-attack. It is concluded from flow visualization that the nozzle ought not to be placed

near the core of vortex, and that if the nozzle is located in such a way that the jet cannot intersect the core of vortex, vortex-dominated flow can be maintained over a larger extent over the wing. Author

A86-37815*# Massachusetts Inst. of Tech., Cambridge.
EULER SOLUTIONS FOR THE FLOW AROUND A HOVERING HELICOPTER ROTOR
T. W. ROBERTS and E. M. MURMAN (MIT, Cambridge, MA) IN: Applied Aerodynamics Conference, 4th, San Diego, CA, June 9-11, 1986, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1986, p. 124-130. refs
(Contract NAG2-275)
(AIAA PAPER 86-1784)

A method for computing the flow around a hovering helicopter rotor is presented. The solution procedure is divided into two parts. The first part is a finite volume solution of the Euler equations for the near field flow around a rotor blade. The second part is a free wake approach for determining the wake geometry and induced velocities. These two parts are solved in a coupled fashion. The rolled-up vortex wake of the rotor is included in the Euler computational domain through a nonlinear perturbation technique. This eliminates the numerical diffusion of the wake vorticity due to truncation error and artificial viscosity without the need for excessive grid resolution near the vortex core. The method is used to compute both hovering rotor and wing/vortex interaction flows, and the results are compared to experiment. Author

A86-37820#
ANALYTICAL OBSERVATIONS ON THE AERODYNAMICS OF A DELTA WING WITH LEADING EDGE FLAPS
S. OH and D. TAVELLA (Stanford University, CA) IN: Applied Aerodynamics Conference, 4th, San Diego, CA, June 9-11, 1986, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1986, p. 170-178. refs
(AIAA PAPER 86-1790)

The effect of a leading edge flap on the aerodynamics of a low aspect ratio delta wing was studied analytically using a simple vortex sheet model and compared with experiments. Particular attention was given to the influence of angle of attack and flap deflection angle on the lift and drag forces. Both lift and drag decrease with flap deflection, while the lift-to-drag ratio increases. A simple coordinate transformation was used to obtain a closed form expression for the lift-to-drag ratio as a function of flap deflection. Qualitative comparison with experiments is presented. Author

A86-37821*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
PROSPECTS FOR DESTRUCTIVE SELF-INDUCED INTERACTIONS IN A VORTEX PAIR DUE TO SINUSOIDAL DISTURBANCES
V. J. ROSSOW (NASA, Ames Research Center, Moffett Field, CA) IN: Applied Aerodynamics Conference, 4th, San Diego, CA, June 9-11, 1986, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1986, p. 179-188. refs
(AIAA PAPER 86-1791)

The vortex wakes of large transport aircraft can pose a hazard to smaller following aircraft in the vicinity of airports during landing and take-off operations if certain separation guidelines are not observed. In order to reduce the hazard potential, and thereby the separation distances, efforts are being made to find more rapid wake-dissipation mechanisms. In this paper numerical simulations are made of the three-dimensional time-dependent instabilities that might be initiated in a vortex pair by sinusoidal displacements of the filaments. The objective of the study was to find those displacements and phase angles that would produce the most rapid destruction of the vortices. It is concluded that, of the wave patterns tried on the one pair of wake filaments, the only instability mode that leads to destructive interactions of the vortices is the Scorer-Crow process. Author

A86-37823#
A TWO-DIMENSIONAL TRANSONIC AERODYNAMIC DESIGN METHOD
M. GILES and M. DRELA (MIT, Cambridge, MA) IN: Applied Aerodynamics Conference, 4th, San Diego, CA, June 9-11, 1986, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1986, p. 197-204. refs
(Contract F49620-78-C-0084)
(AIAA PAPER 86-1793)

This paper demonstrates the capabilities of a new transonic, two-dimensional design method. The method is based upon the simultaneous solution of multiple streamtubes, coupled through the position of, and pressure at, the streamline interfaces. This allows the specification of either the airfoil shape (direct, analysis mode) or the airfoil surface pressure distribution (inverse, design mode). The nonlinear system of equations is formulated in a conservative manner which guarantees the correct treatment of shocks, and is solved by a rapid Newton solution method. Viscous effects can also be included through a coupled integral boundary layer analysis. The first set of results shows the effect of different far-field treatments, demonstrating the improvement in accuracy obtained by including the second-order doublet terms in addition to the usual first-order vortex term. They also compare the results to ones obtained by specifying straight far-field streamlines (corresponding to solid wall wind tunnel experiments) or constant far-field pressure (corresponding to free jet experiments) to show the sensitivity to the far-field distance. In the second set of results the method is used to design a transonic airfoil with $C(l) = 1.000$ at freestream Mach number = 0.70. It is shown that the off-design performance is improved by specifying a surface pressure distribution with a very weak shock. Viscous effects are also assessed. Author

A86-37824#
A SPECTRAL HODOGRAPH METHOD FOR SHOCKLESS TRANSONIC TWO-DIMENSIONAL FLOW
C. MAVRIPLIS (MIT, Cambridge, MA) and W. L. HARRIS (Connecticut, University, Storrs) IN: Applied Aerodynamics Conference, 4th, San Diego, CA, June 9-11, 1986, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1986, p. 205-213. NSERC-supported research. refs
(Contract N00014-82-K-0311)
(AIAA PAPER 86-1796)

An iterative numerical method involving a Chebyshev-Fourier pseudo-spectral method is constructed for the solution of two-dimensional shockless transonic potential flow in the hodograph plane. The problem is posed in the hodograph plane where the governing equation is a linear variable coefficient mixed (hyperbolic-elliptic) partial differential equation where complications due to singularities and boundary conditions arise. A numerical/analytical method is devised to solve the equation efficiently and accurately for the streamfunction. Interpolated pseudo-spectral solutions for a zero streamfunction are integrated analytically back to the physical plane to yield body coordinates. The method is tested on the design of a NACA 0012 airfoil as well as a NLR quasi-elliptical airfoil starting from a circular cylinder. In its present form the method is efficient but limited to simple bodies in transonic flow as well as sensitive to certain input parameters. Further work on this method is to extend it to yield a very efficient inverse design method for shockless airfoils in transonic flow. Author

A86-37825*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
PLANFORM EFFECTS FOR LOW-FINENESS RATIO MULTIBODY CONFIGURATIONS AT SUPERSONIC SPEEDS
S. N. MCMILLIN and R. M. WOOD (NASA, Langley Research Center, Hampton, VA) IN: Applied Aerodynamics Conference, 4th, San Diego, CA, June 9-11, 1986, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1986, p. 214-220. refs
(AIAA PAPER 86-1799)

An experimental and theoretical investigation of planform effects on a low-fineness ratio multibody configuration has been conducted in NASA Langley Research Center's Unitary Plan Wind Tunnel at Mach numbers 1.6, 1.8, 2.0, and 2.16. Experimental and theoretical values of lift, drag, and pitching moment were obtained on three configurations which varied in outboard panel planform only. The three variations were at 65 deg delta, a 70/66 deg cranked arrow, and a 20 deg trapezoidal planform . The purpose of the study was to determine the effect of wing planform on the supersonic aerodynamics and to evaluate the ability of two existing linearized-theory aerodynamic methods to predict these effects. Experimental data showed that the planforms produced the lift, drag-due-to-lift, and pitching-moment characteristics typically found on single-body configurations. However, the data also showed that planform has a minimal influence on zero-lift drag, which is not typical of single-body configurations. Theoretical aerodynamic analysis indicated that codes based on linearized theory adequately predicted the effect of planform on the supersonic aerodynamics. Author

A86-37826#
AERODYNAMIC EFFECTS OF WINGTIP-MOUNTED PROPELLERS AND TURBINES
L. R. MIRANDA and J. E. BRENNAN (Lockheed-California Co., Burbank) IN: Applied Aerodynamics Conference, 4th, San Diego, CA, June 9-11, 1986, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1986, p. 221-228. refs
(AIAA PAPER 86-1802)

A simple analytical model of the interaction between a wing and propellers or turbines is formulated and discussed in this paper. This model is particularly suited to study wingtip-mounted propellers or turbines. The computer program based on the present method, known as PROPWING, also allows the determination of the optimum spanload distribution for a wing in the presence of propellers. Correlation with available experimental data proves the validity of the subject methodology for preliminary design application. Numerical studies conducted with PROPWING indicate that substantial performance benefits can be achieved by properly mounting the propellers at the wingtips. These results appear to confirm a similar conclusion derived by NASA-Langley researchers from wind tunnel investigations of wingtip-mounted propellers and turbines. Author

A86-37830#
COUNTERFLOW SONIC NOSEJET INTO A SUPERSONIC STREAM
J. H. FOX (Calspan Corp., Arnold Air Force Station, IN) IN: Applied Aerodynamics Conference, 4th, San Diego, CA, June 9-11, 1986, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1986, p. 250-255. refs
(AIAA PAPER 86-1808)

The flow field resulting from a sonic nosejet issuing counter to a supersonic stream is computed using an implicit, thin-layer Navier-Stokes solver with bow-shock fitting. A hemisphere-cylinder submerged in a Mach 2.5 stream is analyzed. The nosejet has a nozzle diameter equal to 0.13 cylinder diameters. This configuration has a very large recirculating flow region adjacent to the jet. Comparisons of the computed pressure distribution on the nose with measured data are presented and show good agreement. The attachment location of the separated stream on the hemisphere nose is also well predicted. Various features of the flow are discussed. To demonstrate the method further, an additional computation is presented of a sonic jet issuing from an ogive nose into a Mach 6 stream. The features of the computed flow field again compare very well with experiment. Author

A86-37831#
FLOW STRUCTURE OF LATERAL WING-TIP BLOWING
C. S. LEE, D. TAVELLA, N. J. WOOD, and L. ROBERTS (Stanford University, CA) IN: Applied Aerodynamics Conference, 4th, San Diego, CA, June 9-11, 1986, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1986, p. 256-264. refs
(AIAA PAPER 86-1810)

Flow field surveys of the near wake behind a rectangular wing with lateral blowing were made by using a five-hole probe in a low speed wind tunnel. The effect of the jet configuration on the wake structure was investigated by offsetting the jet vertically from the chord line and deflecting the jet relative to the span. The enhancement of lift by the jet blowing was found to be an inviscid characteristic. The favorable lift increments of the slanted down and offset up blowing were mainly due to larger displacement of the tip vortices resulting from a complex three dimensional interaction of the asymmetric jet in a cross flow. Secondary vortices rotating in the opposite direction to the primary vortices were observed for the cases with favorable lift augmentation. The presence of secondary vortices has a significant influence on the position of the primary vortices, which affects the lift increment along the whole span. The tip vortices are considerably diffused by weak lateral blowing. Author

A86-37832#
PAN AIR ANALYSIS OF A TRANSPORT HIGH-LIFT CONFIGURATION
E. N. TINOCO, C. N. BALL, and F. A. RICE, II (Boeing Commercial Airplane Co., Seattle, WA) IN: Applied Aerodynamics Conference, 4th, San Diego, CA, June 9-11, 1986, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1986, p. 265-271. refs
(AIAA PAPER 86-1811)

PAN AIR panel method analyses of the 737-300 Flaps 1 and Flaps 15 takeoff configurations were performed in support of the aircraft's flight development phase during precertification flight test. The analyses were instrumental in helping to understand the complex flow phenomena about the aircraft and contributed to performance improvements in the final FAA certified configuration. Comparisons of computed results with inflight measurements of wing and nacelle pressure distributions, wing section lift coefficients, and aircraft L/D are presented. A description of the computational modeling is also included. Author

A86-37833*# Wichita State Univ., Kans.
THE USE OF CURVED HIGHER ORDER PANELS FOR VORTEX SHEET MODELING
M. G. NAGATI (Wichita State University, KS), J. D. IVERSEN, and J. M. VOGEL (Iowa State University of Science and Technology, Ames) IN: Applied Aerodynamics Conference, 4th, San Diego, CA, June 9-11, 1986, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1986, p. 272-280. Research supported by Wichita State University and NASA. refs
(AIAA PAPER 86-1812)

A method is presented for predicting the geometry of a vortex sheet trailing a lift generating wing in its vicinity. It differs from others in that it uses a continuous vorticity distribution rather than discrete vortex filaments. It was found that the results were in good agreement with available experimental data, after the initial cycle of what was to be a relaxation scheme, so that iterations for this end were unnecessary. While the technique is computing intensive, it becomes attractive when used in conjunction with panel methods applications for complete aircraft configurations. The panel method solution needs to be found only once for each streamwise station downstream of the wing. Corrections applied are geometric in nature and are independent of other computational aspects. Author

A86-37834#
A HIGH ORDER SUPERSONIC TRIPLET SINGULARITY
F. A. WOODWARD IN: Applied Aerodynamics Conference, 4th, San Diego, CA, June 9-11, 1986, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1986, p. 281-287. refs
(AIAA PAPER 86-1815)

Constant and linear distributions of triplet singularities are derived, and compared with the high order source and doublet singularities used in PANAIR. The new singularities are designed to provide piecewise linear continuity of singularity strength across all panel edges, and utilize a sub-paneling technique if necessary to enforce geometrical continuity. The singularities are built up by combining the influences of these basic distributions over 6 or 9 panel groups surrounding the control point, and effectively minimize the number of equations required to satisfy the boundary conditions of tangential flow on the external surface of the body. Author

A86-37837*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
SUPERSONIC AIRFOIL OPTIMIZATION
J. L. PITTMAN (NASA, Langley Research Center, Hampton, VA) IN: Applied Aerodynamics Conference, 4th, San Diego, CA, June 9-11, 1986, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1986, p. 302-309, 45. refs
(AIAA PAPER 86-1818)

A procedure for the optimization of supersonic airfoils is presented. A nonlinear, full-potential solver (NCOREL) is coupled with a numerical optimizer (CONMIN). The NCOREL code is a three-dimensional supersonic marching method, however, only two-dimensional (conical) results are used for the airfoil problem. Each airfoil evaluated in the NCOREL aerodynamic code is composed of a linear combination of user-specified basis airfoils. The weighting factors of the basis airfoils plus the angle of attack form the design variable vector. The inviscid drag coefficient is minimized subject to lift and crossflow Mach number gradient constraints. The optimization strategy is found to be extremely important for the efficient determination of an optimum airfoil. Author

A86-37838#
THREE-DIMENSIONAL INTERACTION OF WAKES AND BOUNDARY LAYERS
L. C. SQUIRE (Cambridge University, England) and A. H. KH. MOGHADAM IN: Applied Aerodynamics Conference, 4th, San Diego, CA, June 9-11, 1986, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1986, p. 310-319. refs
(AIAA PAPER 86-1820)

This work concerns a fundamental study of the three-dimensional aspects of the wake/boundary layer interaction as it occurs on high-lift wings, particularly the slat-wake/wing boundary layer interaction. A digital system for measuring and recording all the components of the mean velocity and the Reynolds stress tensor using a triple hot-wire probe has been developed. This system has been tested and has been used to measure the interaction between the wakes of swept aerofoils and the fully turbulent boundary layer developing on a flat plate. An important result is that the three-dimensional aspects of this flow decay quickly downstream of the aerofoil. Two cases of three-dimensional interaction have been simulated. In one case the interaction is fully three-dimensional, while in the other case the interaction can be assumed to be quasi-three-dimensional. For the quasi-three-dimensional confluent flow, the measured results have been compared with the predictions of the two-dimensional form of K-epsilon and algebraic stress turbulence models. The overall agreement between the measured and predicted results is good. However, for the turbulence flow field the agreement is less satisfactory in the initial mixing region where the three-dimensionality is strong, and it is also poor in the wall boundary layer. Author

A86-37840*# California Univ., Davis.
DRAG-REDUCTION CHARACTERISTICS OF AFT-SWEPT WING TIPS
C. P. VAN DAM (California, University, Davis) IN: Applied Aerodynamics Conference, 4th, San Diego, CA, June 9-11, 1986, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1986, p. 327-338. refs
(Contract NAS1-17797)
(AIAA PAPER 86-1824)

Results are presented of a study conducted to analyze the potential aerodynamic improvements which can be obtained with aft-swept wing tips at subsonic speeds. A review and summary of previous swept-tip applications and studies are given. Additionally, the through evolution optimized tail-fin shapes of fast-cruising aquatic animals are examined as well as the wing planform shapes of sea birds. These superior long-distance travellers both display lifting-surface planform shapes with increased leading-edge sweep towards the tip. These observations and analytical results obtained with a nonlinear surface-panel method demonstrate that substantial induced-drag improvements can be obtained through the adoption of planform shapes with highly-tapered aft-swept tips. Author

A86-37841#
WING AND CONICAL BODY OF ARBITRARY CROSS-SECTION COMBINATIONS IN SUPERSONIC FLOW
D. MATEESCU (McGill University, Montreal, Canada) IN: Applied Aerodynamics Conference, 4th, San Diego, CA, June 9-11, 1986, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1986, p. 339-347. refs
(AIAA PAPER 86-1826)

This paper presents an analysis of wing and conical body of arbitrary cross-section combinations in supersonic flow. Particular emphasis is given to the delta wing and elliptic cone combinations, for which analytical solutions are obtained for the spanwise variation of the lifting load coefficient; both cases of subsonic and supersonic leading edges are equally treated. In this formulation the wind incidence is allowed to change along the span, as in the case of wingbody systems with leading edge flaps, or with a continuously variable wing incidence. The theoreticcal solutions obtained for the delta wing and elliptic cone systems are in good agreement with Jorgensen's experimental results for various Mach numbers, wing spans and cross-sectional semi-axis ratios. Good agreement with the experimental results is also observed in the limit case of isolated elliptic cones. Author

A86-37842#
THE EXTERNAL DRAG OF A SIMPLE AXISYMMETRIC BODY OF REVOLUTION IN SUBSONIC AND SUPERSONIC FLOW WITH VARIABLE MASS FLOWTHROUGH RATIOS
T. OSAWA (UBE Industries, Ltd., Tokyo, Japan) and H. HEWITT (Tennessee Technological University, Cookeville) IN: Applied Aerodynamics Conference, 4th, San Diego, CA, June 9-11, 1986, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1986, p. 348-354. refs
(AIAA PAPER 86-1828)

The external wave drag of a simple axisymmetric body of revolution was obtained by numerically solving the time-dependent Euler equations. The numerical algorithm used was MacCormack's explicit scheme for Mach numbers from 0.8 to 4.0. The four cases studied included a closed body, and open body with and without sting supports, and an open body with flow spillage at the intake of the flow-through duct. In order to simulate the flow spillage, a boundary was set at the inlet of the duct. The boundary condition was obtained by the one-dimensional normal shock assumption which was developed by Wyatt to given an additive drag. As a result, the present method gave good agreement with a perturbation solution for the closed body. For the open body without flow spillage, the wave drag coefficients were found to be larger than for the closed body. The boundary condition at the inlet of the flow-through duct successfully simulated the flowfield near the intake for the case of the open body with spillage. This case was also compared with experimental data, assuming the friction drag was constant, and gave good agreement. Author

A86-37846*# Kansas Univ., Lawrence.
CALCULATION OF ASYMMETRIC VORTEX SEPARATION ON SLENDER DELTA WINGS WITH A VORTEX-SHEET MODEL
C. E. LAN (Kansas, University, Lawrence) IN: Applied Aerodynamics Conference, 4th, San Diego, CA, June 9-11, 1986, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1986, p. 391-400. refs
(Contract NSG-1629)
(AIAA PAPER 86-1836)

An inviscid vortex-sheet model based on the slender wing theory is developed to examine asymmetric vortex separation at zero sideslip on delta wings. It is found that multiple asymmetric vortex configurations exist at a given angle of attack. Available data on rolling moment measurements and flow visualization are used for correlation to prove the concept. Author

A86-37847*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
AN IMPLICIT FLUX-DIFFERENCE SPLITTING SCHEME FOR THREE-DIMENSIONAL, INCOMPRESSIBLE NAVIER-STOKES SOLUTIONS TO LEADING EDGE VORTEX FLOWS
P.-M. HARTWICH (NASA, Langley Research Center, Hampton, VA) and C.-H. HSU (Kansas, University, Lawrence) IN: Applied Aerodynamics Conference, 4th, San Diego, CA, June 9-11, 1986, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1986, p. 401-410. refs
(Contract NAG1-455)
(AIAA PAPER 86-1839)

A new, implicit finite-difference scheme designed to solve the conservative, flux-difference split Navier-Stokes equations is used to compute incompressible vortex flows around delta wings. The completely vectorizable hybrid algorithm is constructed in delta form for steady state solutions independent of the time-step sizes. The scheme combines approximate factorization in crossflow planes with a symmetric planar Gauss-Seidel relaxation in the remaining spatial direction. The governing equations are solved in curvilinear, body-fitted coordinates for treating complex geometries. The computed flow field results are compared with other theoretical and experimental data. Author

A86-37848*# Massachusetts Inst. of Tech., Cambridge.
A COMPARISON OF EXPERIMENTAL AND NUMERICAL RESULTS FOR DELTA WINGS WITH VORTEX FLAPS
K. G. POWELL, E. M. MURMAN (MIT, Cambridge, MA), R. M. WOOD, and D. S. MILLER (NASA, Langley Research Center, Hampton, VA) IN: Applied Aerodynamics Conference, 4th, San Diego, CA, June 9-11, 1986, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1986, p. 411-424. refs
(Contract NAG1-358)
(AIAA PAPER 86-1840)

Computational and experimental results are presented for delta wings with vortex flaps. The wings have an undeflected leading-edge sweep of 75 deg. Flap angles of 5 deg and 10 deg, measured in the streamwise direction, are considered. The nominal angle of attack alpha is varied from 4 deg to 12 deg. Results for freestream Mach numbers of 1.7 and 2.4 are shown. Surface pressure, tuft patterns and vapor screens are given for the experimental data. Surface pressure, tuft patterns, cross-flow velocities, total pressure loss and cross-flow Mach number are given for the numerical data. C(l)-vs-alpha curves are shown for experimental and computational results. The flows are shown to be very sensitive to angle of attack, and the agreement between experimental and theoretical results is improved if the calculations are made at angles of attack slightly larger than the experimental angles of attack. The computational model correctly predicts the topology of the flow in each of the cases considered. The lift is predicted well at the higher angles of attack, but slightly overpredicted at the lower angles of attack. Author

A86-37901
SPREADING OF TWO-STREAM SUPERSONIC TURBULENT MIXING LAYERS
N. CHINZEI, G. MASUYA, T. KOMURO, A. MURAKAMI, and K. KUDOU (National Aerospace Laboratory, Kakuda, Japan) Physics of Fluids (ISSN 0031-9171), vol. 29, May 1986, p. 1345-1347. refs

Two-stream supersonic turbulent mixing layers with a free-stream Mach number of 2.3 on the high-velocity side are experimentally investigated. A large-scale vortical structure, which has been believed to dominate the development of incompressible mixing layers, is also observed in the present supersonic layers. The spreading rate of the layer is correlated with a velocity ratio of the free streams and a Mach number based on the velocity difference across the layer. Author

A86-38258* Aerometrics, Inc., Mountain View, Calif.
APPLICATION OF OPTICAL INTERFEROMETRY IN COMPRESSIBLE FLOWS
W. D. BACHALO (Aerometrics, Inc., Mountain View, CA) IN: ICIASF '85 - International Congress on Instrumentation in Aerospace Simulation Facilities, 11th, Stanford, CA, August 26-28, 1985, Record . New York, Institute of Electrical and Electronics Engineers, 1985, p. 277-287. NASA-supported research. refs

Interferometry methods were applied to the investigation of steady and unsteady flows in large scale transonic wind tunnels. Holographic interferometry was demonstrated to provide reliable flow visualization and quantitative results for a number of two-dimensional flows. These conclusions were based on extensive comparisons with results obtained by other means. Data obtained on a NACA 64A010 airfoil with an oscillating flap installed in the Ames 11-foot transonic tunnel are presented. Interferograms were recorded at a free stream Mach number of 0.8, flap frequency of 30 Hertz and chord Reynolds numbers of 6.6 x 10 to the 6th and 12.3 x 10 to the 6th. The interferometric results were reduced to dynamic surface pressures, Mach contours and wake flow profiles. A new interferometry method that is capable of providing real-time interferometry data is also discussed. Author

A86-38305* Vigyan Research Associates, Inc., Hampton, Va.
SWEPT WING-TIP SHAPES FOR LOW-SPEED AIRPLANES
C. P. VAN DAM (Vigyan Research Asociates, Inc., Hampton, VA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 12 p. refs
(Contract NAS1-17797)
(SAE PAPER 851770)

Preliminary results are presented of a study conducted to analyze the effects of several plan-form modifications on the aerodynamic characteristics of a high-aspect-ratio, natural laminar flow (NLW) wing. The study addresses the potential aerodynamic improvements available at both cruise and high angles of attack by use os swept wing-tip shapes. The swept wing tip appears to offer a viable addition to the lift of wing-tip designs which provide improvements in aerodynamic efficiency, with the added safety benefit of providing high angle-of-attack departure resistance. Author

A86-38306
THE X-29 - A UNIQUE AND INNOVATIVE AERODYNAMIC CONCEPT
D. FREI and M. MOORE (Grumman Corp., Bethpage, NY) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA. Oct. 14-17, 1985. 12 p. DARPA-supported research. refs
(SAE PAPER 851771)

The X-29 was conceived to demonstrate in-flight the potential advantages of several advanced and innovative technologies integrated into one vehicle design. These advanced technologies include: (1) a forward-swept wing employing a thin supercritical airfoil; (2) aeroelastically-tailored composite wing covers to control divergence; (3) a close-coupled, variable-incidence canard; (4) variable wing camber; and (5) three-surface trim configuration. An aerodynamic overview of the configuration development and integration of these technologies is presented. Wind tunnel results

and flight test results, where available, are also presented to substantiate the advantages of these innovative concepts.
Author

A86-38313
COMPUTATIONAL AERODYNAMIC DESIGN - X-29, THE GULFSTREAM SERIES AND A TACTICAL FIGHTER
C. W. BOPPE (Grumman Corp., Bethpage, NY) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 47 p. refs
(SAE PAPER 851789)

Elements of computational aerodynamic design are described by tracing the development of three different aircraft configuration types. The Gulfstream series (G-II, G-III, and G-IV) illustrates from 1966 to the present the evolution of both computational tools and design philosophy. This transport experience is augmented by two distinct fighter designs that feature transonic maneuver requirements: the X-29 Forward Swept Wing Demonstrator Aircraft and a generic tactical fighter configuration. These state-of-the-art applications show how courses are charted to circumvent limitations in computerized flow simulation techniques. Problems associated with drag prediction, complex geometry modeling, nonpotential phenomena, and code convergence for extreme conditions/shapes are addressed. Primary topics in wing design are complemented with auxiliary studies performed on canards, tails, nacelles, and winglets to provide perspective for the total aircraft development process. Good and bad experiences are included. Computational Fluid Dynamics (CFD) impact is evaluated by means of performance levels achieved (wind tunnel and flight test data), resources saved, and insight provided for unscrambling complex aircraft synthesis problems. Future CFD requirements are discussed. Author

A86-38314
REDUCED NAVIER-STOKES (RNS RELAXATION PROCEDURE FOR INTERNAL FLOWS WITH INTERACTION)
D. R. REDDY, R. A. DELANEY (General Motors Corp., Allison Gas Turbine Div., Indianapolis, IN), and S. G. RUBIN (Cincinnati, University, OH) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 12 p. refs
(SAE PAPER 851790)

A multisweep relaxation procedure is considered in the following study for two-dimensional and three-dimensional internal flows with interaction using reduced (pressure-elliptic) Navier-Stokes (RNS) equations. The velocities and pressures are fully coupled in the algorithm, and the pressure gradient in the streamwise momentum equation is appropriately treated to simulate the elliptic interaction. A Poisson type of equation is not required. The continuity equation is directly satisfied everywhere in the flow domain. Incompressible flow solutions are obtained for a two-dimensional channel with a backward facing step and a three-dimensional duct with square cross section. The solution for these test cases demonstrates the capability of the RNS algorithm to solve internal flows with strong interaction encountered in turbomachinery passages. Author

A86-38315
OPTIMIZATION OF A SUPERSONIC WING BY COMBINING LINEAR AND EULER METHODS
J. M. ROSS, J. S. REASER, and E. E. BOUCHARD (Lockheed-California Co., Burbank) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 9 p. refs
(SAE PAPER 851791)

A combination of linear and nonlinear methods was found to be effective in designing a supersonic fighter wing. The design Mach number was 1.6, with cruise and maneuver lift coefficients of 0.1 and 0.4. The planform was a tapered arrow wing with a subsonic leading edge. It was chosen based on general aerodynamic principles tempered with practical considerations. Initial camber and twist distributions were determined from a linear method. An Euler code was then used to improve upon the linear design; chordwise loading was made more uniform, and spanwise loading was adjusted toward the ideal elliptic distribution. The nonlinear calculations suggest the best approach is to use the linear method optimization at half the desired lift coefficient, and then to modify the design based on nonlinear analysis. Author

A86-38316
ENGINEERING APPLICATIONS OF AN ADVANCED LOW-ORDER PANEL METHOD
C. E. JOHNSTON, H. H. YOUNGREN, and J. S. SIKORA (Lockheed-California Co., Burbank) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 10 p. refs
(SAE PAPER 851793)

Panel methods have become important aerodynamic prediction tools for aircraft design and analysis. To demonstrate the utility and accuracy of panel methods, three applications illustrating their usage are discussed in this paper. The computer code used is Lockheed's advanced low-order QUADrilateral element PANel method (QUADPAN). The first case presents correlation of force and moment predictions on a Lockheed P-3 Orion aircraft with rotodome for airborne early warning and control (AEW and C). The ability to predict incremental effects due to the rotodome is demonstrated. The second application investigates the local flow behavior in the vicinity of the engine pylon and nacelle for a re-engined Boeing 727 derivative aircraft. Results include surface pressure distributions and the local flow characteristics using the flow-survey capability of QUADPAN. Finally, the third compares stability and rate derivative calculations for the Rockwell Space Shuttle atmospheric re-entry vehicle to wind tunnel and flight test data. Author

A86-38326
APPLICATION OF THE VORTEX-LATTICE METHOD TO HIGH-ANGLE-OF-ATTACK SUBSONIC AERODYNAMICS
D. T. MOOK and A. H. NAYFEH (Virginia Polytechnic Institute and State University, Blacksburg,) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 18 p. refs
(Contract N00014-85-K-0011; AF-AFOSR-85-0158; NR PROJECT 061-201)
(SAE PAPER 851817)

The vortex-lattice method for general, unsteady, incompressible aerodynamics is described. This method can treat multiple lifting surfaces operating in close proximity, fully accounting for interference. It is not limited by planform, camber, twist, or maneuver as long as separation occurs only along known lines and vortex bursting does not occur near one of the lifting surfaces. Steady flows can be treated efficiently as special cases of uniform motion. Several examples are presented as a partial illustration of the range of problems that can be treated. These include steady and unsteady flows over rectangular and delta wings, a numerical simulation of the wing rock phenomenon, and steady and unsteady interference among two canards and a wing. In the numerical simulation of wing rock, the equation governing the motion of a delta wing mounted on a free-to-roll sting is integrated numerically by a predictor-corrector method with the aerodynamic roll moment being supplied by the vortex-lattice method. This numerical solution determines the motion of the wing and the flow-field simultaneously, fully accounting for the aerodynamic/dynamic interaction. The numerical solutions are in good agreement with available experimental data. Author

A86-38327* North Carolina State Univ., Raleigh.
A THREE-DIMENSIONAL BOUNDARY-LAYER METHOD FOR FLOW OVER DELTA WINGS WITH LEADING-EDGE SEPARATION
S. H. WOODSON and F. R. DEJARNETTE (North Carolina State University, Raleigh) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 13 p. refs
(Contract NCC1-22; NCC1-46)
(SAE PAPER 851818)

A three-dimensional, laminar boundary-layer method is applied to the incompressible flow over a slender delta wing at incidence. The predictor-corrector finite-difference scheme of Matsuno is used to difference the governing equations. The method has the

advantages that no iterations are required to advance the solution and the cross-flow derivatives are formed independent of the cross-field direction. The difference scheme is demonstrated to yield accurate numerical results when compared to the exact solution of the three-dimensional boundary-layer equations for parabolic flow over a moving flat plate. The method is applied to delta wings of various sweep angles at angles of attack up to 20 deg., with the inviscid solution determined using a higher-order, three-dimensional panel method. Author

A86-38328
INVISCID AND VISCOUS SIMULATIONS OF HIGH ANGLE OF ATTACK FLOWS
D. K. OTA, S. R. CHAKRAVARTHY, and J. J. GORSKI (Rockwell International Science Center, Thousand Oaks, CA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 15 p. refs
(SAE PAPER 851820)

High angle of attack flow for a NACA0012 airfoil has been computed using an Euler code and a Navier-Stokes code. These codes are based on an implicit finite-volume Total-Variation-Diminishing (TVD) formulation of the convection terms. Comparison of the two solutions shows that the Euler code does not result in a realistic separated flow solution while the Navier-Stokes code does. Author

A86-38347* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
A FASTER 'TRANSITION' TO LAMINAR FLOW
P. J. BOBBLTT, E. G. WAGGONER, W. D. HARVEY, and J. R. DAGENHART (NASA, Langley Research Center, Hampton, VA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 28 p. refs
(SAE PAPER 851855)

A discussion is given of the ongoing research related to laminar flow airfoils, nacelles, and wings where the laminar flow is maintained by a favorable pressure gradient, surface suction or a combination of the two. Design methologies for natural laminar flow airfoil sections and wings for both low and high speed applications are outlined. Tests of a 7-foot chord, 23-deg sweep laminar flow-control airfoil at high subsonic Mach numbers are described, along with the associated stability theory used to design the suction system. The state-of-the-art of stability theory is simply stated and a typical calculation illustrated. In addition, recent computer simulations of transition using the time dependent Navier-Stokes equations are briefly described. Advances in wind tunnel capabilities and instrumentation will be reviewed, followed by the presentation of a few results from both wind tunnels and flight. Finally, some suggestions for future work will complete the paper. Author

A86-38412*# Washington Univ., Seattle.
EXPERIMENTS ON SUPERSONIC TURBULENT FLOW DEVELOPMENT IN A SQUARE DUCT
F. B. GESSNER (Washington, University, Seattle), S. D. FERGUSON (Boeing Aerospace Co., Seattle, WA), and C. H. LO (Spectra Technology, Inc., Flow Technology Div., Bellevue, WA) AIAA and ASME, Fluid Mechanics, Plasma Dynamics and Lasers Conference, 4th, Atlanta, GA, May 12-14, 1986. 10 p. refs
(Contract NGR-48-002-141)
(AIAA PAPER 86-1038)

The nature of supersonic, turbulent, adiabatic-wall flow in a square duct is investigated experimentally over a development length of x/D between 0 and 20 for a uniform flow, Mach 3.9 condition at the duct inlet. Initial discussion centers on the duct configuration itself, which was designed specifically to minimize wave effects and nozzle-induced distortion in the flow. Total pressure contours and local skin friction coefficient distributions are presented which show that the flow develops in a manner similar to that observed for the incompressible case. In particular, undulations exist in total pressure contours within the cross plane and in transverse skin friction coefficient distributions, which are indicative of the presence of a well-defined secondary flow superimposed upon the primary flow. The results are analyzed to show that local law-of-the-wall behavior extends well into the corner region, which implies that wall functions conventionally applied in two-equation type turbulence models, when suitably defined for compressible flow, may also be applied to supersonic streamwise corner flows. Author

A86-38420*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
NAVIER-STOKES COMPUTATIONS OF LEE-SIDE FLOWS OVER DELTA WINGS
J. L. THOMAS and R. W. NEWSOME (NASA, Langley Research Center, Hampton, VA) AIAA and ASME, Fluid Mechanics, Plasma Dynamics and Lasers Conference, 4th, Atlanta, GA, May 12-14, 1986. 16 p. refs
(AIAA PAPER 86-1049)

Solutions to the Navier-Stokes equations for the flow over delta wings are computed with emphasis on the separated vortical flows developing on the lee side at high angles of attack. A recently developed implicit algorithm is used which employs upwind differencing for the pressure and convection terms and central differencing for the shear stress and heat transfer terms. Solutions to both the three-dimensional equations and the approximate conical flow equations are compared parametrically with an extensive experimental data base at supersonic speeds. The computations indicate that the conical flow approximation provides results in close agreement with the three-dimensional equations, even to angles of attack as high as 20 degrees. Good agreement with experimentally measured pressures and vapor screen photographs is obtained for the conditions investigated. The method predicts the classical pattern of vortical flow over a delta wing and transition to other flow patterns as the leading edge sweep angle and leading edge normal Mach number are varied. C.D.

A86-38433*# Notre Dame Univ., Ind.
EXPERIMENTAL DETERMINATION OF THE LAMINAR SEPARATION BUBBLE CHARACTERISTICS ON AN AIRFOIL AT LOW REYNOLDS NUMBERS
M. M. OMEARA and T. J. MUELLER (Notre Dame, University, IN) AIAA and ASME, Fluid Mechanics, Plasma Dynamics and Lasers Conference, 4th, Atlanta, GA, May 12-14, 1986. 13 p. Research supported by the University of Notre Dame. refs
(Contract NSG-1419)
(AIAA PAPER 86-1065)

An experimental investigation was conducted in order to document the structure and behavior of laminar separation bubbles at low Reynolds numbers. Data of this type is necessary if the currently insufficient analytical and numerical models are to be improved. The laminar separation bubble which forms on a NACA 66(3)-018 airfoil model was surveyed at chord Reynolds numbers ranging from 50,000 to 200,000 at angles of attack from 8 to 12 degrees. The effects of the various testing conditions on the separation bubble were isolated, and the data was analyzed in relation to existing separation bubble correlations in order to test their low Reynolds number applicability. This analysis indicated that the chord Reynolds number and the disturbance environment strongly influence the experimental pressure distributions. These effects must be included in any analytic prediction technique applied to the low Reynolds number flight regime. Author

A86-38436#
EXPERIMENTAL STUDY OF A TURBULENT HORSESHOE VORTEX USING A THREE-COMPONENT LASER VELOCIMETER
R. ABID and R. SCHMITT (ONERA, Chatillon-sous-Bagneux, France) AIAA and ASME, Fluid Mechanics, Plasma Dynamics and Lasers Conference, 4th, Atlanta, GA, May 12-14, 1986. 9 p. refs
(AIAA PAPER 86-1069)

The turbulent horseshoe vortex flow generated by a simplified wing-body junction has been experimentally studied. Oil surface flow visualization, static wall pressure measurements, and flow field measurements were made in the separated region upstream

of the obstruction leading edge. Mean flow measurements on the plane of symmetry indicate that the three-dimensional separation was confined to a region near the plate. The region of reversed flow was approximately a fifth of the boundary layer thickness. The theoretical streamline pattern suggested by oil surface flow visualization is confirmed. C.D.

A86-38437*# Imperial Coll. of Science and Technology, London (England).

THE INTERACTION BETWEEN A STRONG LONGITUDINAL VORTEX AND A TURBULENT BOUNDARY LAYER

A. D. CUTLER and P. BRADSHAW (Imperial College of Science and Technology, London, England) AIAA and ASME, Fluid Mechanics, Plasma Dynamics and Lasers Conference, 4th, Atlanta, GA, May 12-14, 1986. 12 p. refs

(Contract NASW-581)

(AIAA PAPER 86-1071)

This paper presents the preliminary results of a long-term investigation of the interaction of strong longitudinal vortices with turbulent boundary layers. A pair of trailing vortices is generated by a delta wing, which is mounted ahead of a flat plate so that the trailing vortices merge with the boundary layer on the upper surface of the flat plate, while the non-rolled-up part of the delta-wing wake passes below the plate. This approximates an aircraft wing with a close-coupled canard. The measurements show how the boundary-layer fluid is first subjected to large cross flow and is then transported away from the plate to circulate around the vortex core. Author

A86-38439*# Old Dominion Univ., Norfolk, Va.

INFLUENCE OF NUMERICAL DISSIPATION IN COMPUTING SUPERSONIC VORTEX-DOMINATED FLOWS

O. A. KANDIL and A. CHUANG (Old Dominion University, Norfolk, VA) AIAA and ASME, Fluid Mechanics, Plasma Dynamics and Lasers Conference, 4th, Atlanta, GA, May 12-14, 1986. 15 p. refs

(Contract NAG1-648; NAG1-591)

(AIAA PAPER 86-1073)

Steady supersonic vortex-dominated flows are solved using the unsteady Euler equations for conical and three-dimensional flows around sharp- and round-edged delta wings. The computational method is a finite-volume scheme which uses a four-stage Runge-Kutta time stepping with explicit second- and fourth-order dissipation terms. The grid is generated by a modified Joukowski transformation. The steady flow solution is obtained through time-stepping with initial conditions corresponding to the freestream conditions, and the bow shock is captured as a part of the solution. The scheme is applied to flat-plate and elliptic-section wings with a leading edge sweep of 70 deg at an angle of attack of 10 deg and a freestream Mach number of 2.0. Three grid sizes of 29 x 39, 65 x 65 and 100 x 100 have been used. The results for sharp-edged wings show that they are consistent with all grid sizes and variation of the artificial viscosity coefficients. The results for round-edged wings show that separated and attached flow solutions can be obtained by varying the artificial viscosity coefficients. They also show that the solutions are independent of the way time stepping is done. Local time-stepping and global minimum time-steeping produce same solutions. Author

A86-38443#

BLOCK-STRUCTURED SOLUTION OF EULER EQUATIONS FOR TRANSONIC FLOWS

A. ECER, J. T. SPYROPOULOS, and V. RUBEK (Indiana University; Purdue University, Indianapolis) AIAA and ASME, Fluid Mechanics, Plasma Dynamics and Lasers Conference, 4th, Atlanta, GA, May 12-14, 1986. 10 p. refs

(Contract F49620-83-K-0034)

(AIAA PAPER 86-1080)

A block-structured solution scheme is developed for the solution of Euler equations for steady, three-dimensional, transonic flows. The Euler equations are expressed in terms of Clebsch variables. The resulting set of equations for conservation of mass, entropy (S) and the Clebsch variable eta are solved using a block-based relaxation scheme. The flow field is divided into a series of individual blocks representing local regions of the flow field. The employed grid generation scheme provides local refinement of each block, yet ensures one-to-one matching of grid points on the surfaces of adjoining blocks. For each of the blocks, either potential or Euler equations can be solved. For every block, the conservation of mass equation is solved to determine phi. For blocks with rotationality, two additional equations for determining S and eta are solved. The basic steps of the developed solution scheme are presented. The computational considerations involved in utilizing the present scheme are demonstrated with sample problems. Author

A86-38444*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

THREE-DIMENSIONAL, CONSERVATIVE, EULER COMPUTATIONS USING PATCHED GRID SYSTEMS AND EXPLICIT METHODS

K. A. HESSENIUS and M. M. RAI (NASA, Ames Research Center, Moffett Field, CA) AIAA and ASME, Fluid Mechanics, Plasma Dynamics and Lasers Conference, 4th, Atlanta, GA, May 12-14, 1986. 22 p. refs

(AIAA PAPER 86-1081)

The method of 'zonal approach' (in which the flow field is partitioned into regions with independent grids) for computation of flow over complex geometries, such as aircraft configuration, requires application of a grid-interfacing procedure. A three-dimensional conservative, boundary scheme for patched grids, applicable in generalized coordinates for arbitrary point distributions on a planar zonal surface is presented. The computation technique is derived within the framework of the Osher (1983) upwind scheme, using Euler equations. The three-dimensional interfacing method is applied to the computation of flow about a wing-canard combination using a two-zone, patched grid. I.S.

A86-38445#

TRANSONIC FLOW SOLUTIONS ON A BLUNT, FINNED BODY OF REVOLUTION USING THE EULER EQUATIONS

L. E. LIJEWSKI (USAF, Armament Laboratory, Eglin AFB, FL) AIAA and ASME, Fluid Mechanics, Plasma Dynamics and Lasers Conference, 4th, Atlanta, GA, May 12-14, 1986. 10 p. refs

(AIAA PAPER 86-1082)

Pressure distribution and force and moment calculations are presented for a cruciform, finned body of revolution at angles of attack up to 15 deg. Near sonic conditions at Mach 0.95 are successfully predicted, and preliminary design quality force and moment coefficients are calculated. Crossflow velocity vector plots are presented to substantiate the complex flowfield at angle of attack. Strong vortical flow is captured up to 9-deg angle of attack. An elliptic grid generator and explicit upwind Euler solver were used on a CRAY-XMP to obtain results presented. The paper illustrates the inviscid code's capability to predict aerodynamic characteristics on a geometrically complex configuration at near sonic conditions and moderate angles of attack. Author

A86-38446#

TRANSONIC POTENTIAL FLOW CALCULATIONS BY TWO ARTIFICIAL DENSITY METHODS

G. VOLPE (Grumman Corporate Research Center, Bethpage, NY) and A. JAMESON (Princeton University, NJ) AIAA and ASME, Fluid Mechanics, Plasma Dynamics and Lasers Conference, 4th, Atlanta, GA, May 12-14, 1986. 8 p. refs

(AIAA PAPER 86-1084)

A steady transonic flow over an airfoil is computed by solving the full potential equation discretized over a contour-fitting grid in full conservation form. Near shock waves, the density is corrected to account for the rise in entropy in the region. A multigrid alternating direction method is used to drive the iteration. In supersonic flow regions, artificial dissipation is introduced either by a flux biasing scheme or by a density biasing scheme. The two schemes are second order accurate, while the density biasing scheme is second order accurate throughout the flow field except

for a small region near shock waves. Results of calculations with the two schemes show that the flux biasing scheme gives a sharper resolution of the shock than the density biasing scheme when the shock itself is weak. As shock strength increases, the shock-capturing abilities of the two schemes become equal. Throughout the range of cases tested, the two schemes exhibited comparable speed and robustness. Author

A86-38447*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

EFFECTS OF WIND-TUNNEL NOISE ON SWEPT-CYLINDER TRANSITION AT MACH 3.5

T. R. CREEL, JR., I. E. BECKWITH, and F.-J. CHEN (NASA, Langley Research Center, Hampton, VA) AIAA and ASME, Fluid Mechanics, Plasma Dynamics and Lasers Conference, 4th, Atlanta, GA, May 12-14, 1986. 20 p. refs

(AIAA PAPER 86-1085)

Transition data are reported for circular cylinders at swept angles of 45 and 60 degrees in the Mach 3.5 pilot-low-disturbance tunnel where free-stream noise levels are varied from approximately .05-0.5 percent in terms of the rms fluctuating pressure normalized by the mean static pressure. Results indicate that end plate or boundary layer trip disturbances at the upstream end of the cylinders cause turbulent flow along the entire test Reynolds number range of 10-170 thousand per inch. With all end plate and trip disturbances removed, transition at the attachment lines occurred at free-stream Reynolds numbers based on diameters of about 70-80 thousand, independent of stream noise levels. The installation of small trips on the attachement lines caused transition at lower Reynolds numbers, depending on both the roughness height and the wind tunnel noise level. R.R.

A86-38448*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

EFFECTS OF CONE SURFACE WAVINESS AND FREESTREAM NOISE ON TRANSITION IN SUPERSONIC FLOW

E. L. MORRISETTE, T. R. CREEL, JR., and F.-J. CHEN (NASA, Langley Research Center, Hampton, VA) AIAA and ASME, Fluid Mechanics, Plasma Dynamics and Lasers Conference, 4th, Atlanta, GA, May 12-14, 1986. 7 p. refs

(AIAA PAPER 86-1086)

A comparison of transition on wavy-wall and smooth-wall cones in a Mach 3.5 wind tunnel is made under conditions of either low freestream noise (quiet flow) or high freestream noise (noisy flow). The noisy flow compares to that found in conventional wind tunnels while the quiet flow gives transitional Reynolds numbers on smooth sharp cones comparable to those found in flight. The waves were found to have a much smaller effect on transition than similar sized trip wires. A satisfatory correlating parameter for the effect of waves on transition was simply the wave height-to-length ratio. A given value of this ratio was found to cause the same percentage change in transition location in quiet and noisy flows. Author

A86-38449#

LAMINAR BOUNDARY LAYER STABILITY EXPERIMENTS ON A CONE AT MACH 8. IV - ON UNIT REYNOLDS NUMBER AND ENVIRONMENTAL EFFECTS

K. F. STETSON (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH), E. R. THOMPSON (USAF, Arnold Engineering Development Center, Arnold Air Force Station, TN), J. C. DONALDSON, and L. G. SILER (Calspan Field Servces, Inc., Arnold Air Force Station, TN) AIAA and ASME, Fluid Mechanics, Plasma Dynamics and Lasers Conference, 4th, Atlanta, GA, May 12-14, 1986. 29 p. refs

(AIAA PAPER 86-1087)

Hot wire anemometry is used to experimentally investigate the laminar boundary layer stability of a sharp, 7-deg half angle cone at a freestream Mach value of 8, with attention to the influences of the disturbance environment and unit Reynolds number on boundary layer disturbance growth. The spectral content of the environmental disturbances, and the upper frequency limit for excitation of the boundary layer disturbances are noted to be especially important, with the most important of the environmental disturbances being those of the same frequency as the most unstable boundary layer frequencies. Changing the unit Reynolds number by a factor of 4 did not change the stability characteristics of the boundary layer for frequencies at which environmental excitation was adequate. O.C.

A86-38450#

WALL COOLING EFFECTS ON HYPERSONIC BOUNDARY LAYER TRANSITION, M(1) = 7.5 - 15

H. T. NAGAMATSU (Rensselaer Polytechnic Institute, Troy, NY), R. E. SHEER, JR. (GE Research and Development Center, Schenectady, NY), and D. C. WISLER (GE Fluid Mechanics Laboratory, Evendale, OH) AIAA and ASME, Fluid Mechanics, Plasma Dynamics and Lasers Conference, 4th, Atlanta, GA, May 12-14, 1986. 11 p. refs

(AIAA PAPER 86-1088)

An investigation was conducted in a hypersonic shock tunnel over a Mach number range of 7.5 to 15 to study the effect of wall cooling and surface roughness on laminar boundary layer transition of an 8-ft cone having a 10-deg angle. The stagnation temperature was held approximately constant at 2500 K throughout the investigation, to produce a model wall temperature to stagnation temperature ratio of 0.12. Fast response thin film surface heat transfer gauges were the primary instruments used to detect transition and the passage of turbulent bursts which always appeared at the beginning of the transition region. Pitot-tube, total temperature, and wedge probe heat transfer surveys were made through the boundary layer to verify the interpretation of the surface heat transfer results. The turbulent theory (which included both the density and velocity fluctuation terms) and the laminar theory agreed well with the experiment. The rate of increase for the beginning and end of transition Reynolds number becomes progressively less as freestream Mach number increases above 9. Decreasing the wall-to-stagnation temperature ratio from 0.214 to 0.12, for a 10-deg cone, did not affect the transition Reynolds number. Author

A86-38456*# JAI Associates, Mountain View, Calif.

NUMERICAL SIMULATION OF TIP VORTICES OF WINGS IN SUBSONIC AND TRANSONIC FLOWS

G. R. SRINIVASAN (JAI Associates, Inc., Mountain View, CA), W. J. MCCROSKEY, J. D. BAEDER (NASA, Ames Research Center; U.S. Army, Aeroflightdynamics Directorate, Moffett Field, CA), and T. A. EDWARDS (NASA, Ames Research Center, Moffett Field, CA) AIAA and ASME, Fluid Mechanics, Plasma Dynamics and Lasers Conference, 4th, Atlanta, GA, May 12-14, 1986. 25 p. refs

(Contract DAAG29-85-C-0002)

(AIAA PAPER 86-1095)

A multi block zonal algorithm which solves the thin-layer Navier-Stokes and the Euler equations is used to numerically simulate the formation and roll-up of the tip vortex in both subsonic and transonic flows. Four test cases which used small and large aspect ratio wings have been considered to examine the influence of the tip-cap shape, the tip planform and the free-stream Mach number. It appears that both the tip-planform and the tip-cap shape have some influence on the formation of the tip vortex, but its subsequent roll-up seems to be more influenced by the tip-planform shape. In general, a good definition of the formation and the roll-up of the tip vortex has been observed for all the cases considered here. Comparions of the numerical results with the limited, available experimental data show good agreement with both the surface pressures and the tip-vortex strength. Author

A86-38457#

VISUALIZATION OF WING TIP VORTICES IN UNSTEADY AND STEADY WIND

P. FREYMUTH, F. FINAISH, and W. BANK (Colorado, University, Boulder) AIAA and ASME, Fluid Mechanics, Plasma Dynamics and Lasers Conference, 4th, Atlanta, GA, May 12-14, 1986. 12 p. refs
(Contract F49620-84-C-0065)
(AIAA PAPER 86-1096)

Streakline visualization by smoke near the tip of a rectangular half-wing which protrudes into the center of a wind tunnel test section from the top wall has been conducted at angles of attack 10 deg, 20 deg and 30 deg. The tunnel was either operated in the mode of an accelerating flow starting from rest or in a steady speed mode. The visualizations suggest a novel wing tip vortex system. Vorticity generated at the pressure side of the wing forms a conical tip vortex with its apex at the front corner of wing tip. Another conical tip vortex with the same apex location forms further inboard from vorticity generated at the suction side of the wing. Author

A86-38464#

THREE-DIMENSIONAL UNSTEADY FLOW FIELDS ELICITED BY A PITCHING FORWARD SWEPT WING

J. ASHWORTH, M. WALTRIP, and M. W. LUTTGES (Colorado, University, Boulder) AIAA and ASME, Fluid Mechanics, Plasma Dynamics and Lasers Conference, 4th, Atlanta, GA, May 12-14, 1986. 10 p. refs
(Contract F49620-83-K-0009)
(AIAA PAPER 86-1104)

The three-dimensional flow field about a forward swept, NACA 0015 wing was studied using multiple exposure, phase-locked flow visualization. The flow was viewed from orthogonal perspectives. The wing was oscillated sinusoidally in pitch while stroboscopic photography was used to record the pitching-dependent alterations in flow field structure. Flow interactions were visualized in discrete fashion for a variety of spanwise views, using different k values and mean angle of attack. The major flow field characteristics of the dynamically oscillating swept forward wing were the tip and the leading edge vortices. The strong helical tip flow vortices dominated most of the observed flow structures near the wing tip across all test conditions. The far inboard span locations were dominated by flows related to the leading edge vortex. Whereas the swept forward wing elicits flow structures that are qualitatively predictable from previous research, the magnitude and interaction of these flow structures were quite different. The spatial domain of the flows was quite pronounced and seemed to be specific to the wing geometry of the test configuration. Author

A86-38465#

UNSTEADY AERODYNAMICS OF RAPIDLY PITCHED AIRFOILS

J. C. WU, I. H. TUNCER (Georgia Institute of Technology, Atlanta), and C. M. WANG AIAA and ASME, Fluid Mechanics, Plasma Dynamics and Lasers Conference, 4th, Atlanta, GA, May 12-14, 1986. 14 p. refs
(Contract AF-AFOSR-86-0121)
(AIAA PAPER 86-1105)

The problem of dynamic stall of an airfoil pitched rapidly at a constant rate to large angles of attack is studied computationally. Flow patterns, pressure distributions on the airfoil surface, histories of the lift, the drag and the moment experienced by the airfoil are computed and examined. The computed results are shown to be in good agreement with available experimental data. Author

A86-38473*# Science Applications International Corp., Princeton, N.J.

PROGRESS IN THE DEVELOPMENT OF PARABOLIZED NAVIER-STOKES (PNS) METHODOLOGY FOR ANALYZING PROPULSIVE JET MIXING PROBLEMS

S. M. DASH, D. E. WOLF, N. SINHA, and S. H. LEE (Science Applications International Corp., Propulsion Gas Dynamics Div., Princeton, NJ) AIAA and ASME, Fluid Mechanics, Plasma Dynamics and Lasers Conference, 4th, Atlanta, GA, May 12-14, 1986. 24 p. refs
(Contract NAS1-16535)
(AIAA PAPER 86-1115)

A brief review of 2D PNS methodology is first presented which describes the specialized features of supersonic shock-capturing and subsonic pressure-split models required for the analysis of aircraft, rocket and scramjet jet mixing problems. These features include techniques for dealing with various types of embedded and interfacing subsonic regions, the inclusion of finite-rate chemistry and the direct-coupling with potential flow solutions. Preliminary 3D extensions of this PNS methodology geared to supersonic and subsonic rectangular free jet mixing problems are also reviewed. New 3D PNS work will be described which includes the development of a hybrid supersonic/subsonic free jet mixing model, and, a supersonic model geared to the analysis of turbulent mixing and combustion processes occurring in scramjet combustor/nozzle flowfields. Author

A86-38502* Texas A&M Univ., College Station.

AN INVESTIGATION OF THE EFFECTS OF THE PROPELLER SLIPSTREAM OF A LAMINAR WING BOUNDARY LAYER

R. M. HOWARD, S. J. MILEY (Texas A & M University, College Station), and B. J. HOLMES (NASA, Langley Research Center, Hampton, VA) IN: General aviation aircraft aerodynamics; Proceedings of the General Aviation Aircraft Meeting and Exposition, Wichita, KS, April 16-19, 1985 . Warrendale, PA, Society of Automotive Engineers, Inc., 1985, p. 1-12. refs
(Contract NAG1-344)
(SAE PAPER 850859)

A research program is in progress to study the effects of the propeller slipstream on natural laminar flow. Flight and wind tunnel measurements of the wing boundary layer have been made using hot-film velocity sensor probes. The results show the boundary layer, at any given point, to alternate between laminar and turbulent states. This cyclic behavior is due to periodic external flow turbulence originating from the viscous wake of the propeller blades. Analytic studies show the cyclic laminar/turbulent boundary layer to result in a significantly lower wing section drag than a fully turbulent boundary layer. The application of natural laminar flow design philosophy yields drag reduction benefits in the slipstream affected regions of the airframe, as well as the unaffected regions. Author

A86-38503

AN EXPERIMENTAL STUDY OF A GENERAL AVIATION SINGLE-ENGINE AIRCRAFT UTILIZING A NATURAL LAMINAR FLOW WING

C. OSTOWARI and D. A. NAIK (Texas A & M University, College Station) IN: General aviation aircraft aerodynamics; Proceedings of the General Aviation Aircraft Meeting and Exposition, Wichita, KS, April 16-19, 1985 . Warrendale, PA, Society of Automotive Engineers, Inc., 1985, p. 23-35. refs
(SAE PAPER 850861)

Force and moment measurements, and surface flow patterns have been obtained for a one-fifth scale model of a single-engine general aviation aircraft utilizing a 15-percent thick natural laminar flow wing section. The data is for typical pre- and poststall angles of attack, aircraft yaw attitudes, surface roughness and Reynolds number conditions. Results from a separate study of the wing alone are also given for comparison. This comparison shows that the fuselage/tail assembly acts as a lifting body. The aerodynamic characteristics show marked deterioration with increasing surface roughness. In addition, the studies indicate that the transition on the wing is characterized by laminar short bubble separation. The

aerodynamic characteristics are somewhat unaffected by the presence of minitufts. The flow visualization photographs clearly show the transition and separation regions, and document the effects of variations in angle of attack and yaw on wing body interference. Author

A86-38505

NATURAL LAMINAR FLOW AND REGIONAL AIRCRAFT

K. L. WILLIAMS, P. VIJGEN, and J. ROSKAM (Kansas, University, Lawrence) IN: General aviation aircraft aerodynamics; Proceedings of the General Aviation Aircraft Meeting and Exposition, Wichita, KS, April 16-19, 1985 . Warrendale, PA, Society of Automotive Engineers, Inc., 1985, p. 61-71. refs

(SAE PAPER 850864)

Work done under a NASA-Langley grant at the University of Kansas Flight Research Laboratory in the area of natural laminar flow and regional aircraft is described. The focus is on the application of natural laminar flow over various major wetted areas. In particular, efforts were concentrated on analyzing the potential benefits of achieving extensive laminar flow on the wing, empennage, and fuselage. The effect of the presence of large amounts of laminar flow is evaluated in terms of performance and efficiency improvement over an all-turbulent baseline aircraft. An introduction is given to the concept of regional aircraft, and the aerodynamic characteristics are compared to those of other airplane classes. Some recent aerodynamic developments are presented that justify, to a certain extent, the assumptions made concerning the amount of natural laminar flow that is possible for each surface. Application of a cruise/climb flap to advanced medium-speed natural laminar flow airfoils is also discussed. Author

A86-38507

ANALYTICAL STUDY OF THREE-SURFACE LIFTING SYSTEMS

K. ROKHSAZ and B. P. SELBERG (Missouri-Rolla, University, Rolla) IN: General aviation aircraft aerodynamics; Proceedings of the General Aviation Aircraft Meeting and Exposition, Wichita, KS, April 16-19, 1985 . Warrendale, PA, Society of Automotive Engineers, Inc., 1985, p. 85-94. refs

(SAE PAPER 850866)

Conventional, canard, and three surface aircraft configurations are investigated analytically to determine each configuration's induced drag, as well as the pressure and viscous drag. A vortex panel method in conjunction with momentum integral boundary layer method is used to predict inviscid and viscous characteristics. Vortex lattice methods are used to trim the aircraft as well as to predict the induced drag of each configuration. Viscous and induced drag results are presented for two different payloads, a six-place and a twelve-place configuration. For both payloads the conventional configuration had the highest lift over drag. However, the canard and the three surface were close enough to warrant consideration based on other criteria. Author

A86-38880#

LIFTING SURFACE THEORY FOR THE REST OF US

B. VAN NIEKERK (Stanford University, CA) IN: Structures, Structural Dynamics and Materials Conference, 27th, San Antonio, TX, May 19-21, 1986, Technical Papers. Part 1 . New York, American Institute of Aeronautics and Astronautics, 1986, p. 739-745. refs

(Contract AF-AFOSR-84-0099)

(AIAA PAPER 86-1025)

A rational approach to lifting theory is presented. It is shown that a special numerical integration rule can be found to directly compute the finite part of the characteristic double pole singular integrals found in subsonic lifting surface theories. This is coupled with an optimum weighted residual method which ensures rapid convergence of the aerodynamic generalized forces. The versatility of these techniques is demonstrated by computing the time accurate unsteady airloads on three-dimensional wings. Author

A86-38897*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

UNSTEADY TRANSONIC FLOW CALCULATIONS FOR WING-FUSELAGE CONFIGURATIONS

J. T. BATINA (NASA, Langley Research Center, Hampton, VA) IN: Structures, Structural Dynamics and Materials Conference, 27th, San Antonio, TX, May 19-21, 1986, Technical Papers. Part 2 . New York, American Institute of Aeronautics and Astronautics, 1986, p. 142-155. refs

(AIAA PAPER 86-0862)

The development of the XTRAN3S wing fuselage capability for predicting transonic unsteady aerodynamic loads for aeroplastic applications is described. The modifications of the XTRAN3S code, and XTRAN3S fuselage modeling based on an alternating-direction implicit finite-difference algorithm for solving a modified transonic small-disturbance equation, are analyzed. The XTRAN3S transonic code is applied to the steady and unsteady calculations for three wing-fuselage configurations and a transport-type wing-fuselage model. The effects of fuselage aerodynamic interference on the transonic unsteady air load and flutter characteristics of wings are investigated. Good correlation is detected for the calculated and experimental pressure distributions of the models confirming the validity of the code. I.F.

A86-38898*# Purdue Univ., West Lafayette, Ind.

NONISENTROPIC UNSTEADY THREE DIMENSIONAL SMALL DISTURBANCE POTENTIAL THEORY

M. D. GIBBONS, M. H. WILLIAMS (Purdue University, West Lafayette, IN), and W. WHITLOW, JR. (NASA, Langley Research Center, Hampton, VA) IN: Structures, Structural Dynamics and Materials Conference, 27th, San Antonio, TX, May 19-21, 1986, Technical Papers. Part 2 . New York, American Institute of Aeronautics and Astronautics, 1986, p. 156-165. refs

(Contract NAG1-372)

(AIAA PAPER 86-0863)

Nonisentropic modifications to the three-dimensional transonic small disturbance (TSD) theory, which allows for more accurate modeling of transonic flow fields, are described. The modified flux equation and entropy corrections are presented; the Engquist-Osher differencing (1980) is added to the solution algorithm in order to eliminate the velocity overshoots upstream of shocks. The modified theory is tested in the XTRAN3S finite difference computer code. Steady flows over a rectangular NACA 0012 wing with an aspect ratio of 12 are calculated and compared to Euler equation solutions; good correlation is observed between the data and the modified TSD theory provides more accurate data, particularly for the lift curve slope. The nonisentropic theory is evaluated on an RAE tailplane model for steady and unsteady flows and the modified theory results agree well with the experimental data. I.F.

A86-38900*# California Univ., Los Angeles.

A NEW APPROACH TO FINITE STATE MODELLING OF UNSTEADY AERODYNAMICS

C. VENKATESAN and P. P. FRIEDMANN (California, University, Los Angeles) IN: Structures, Structural Dynamics and Materials Conference, 27th, San Antonio, TX, May 19-21, 1986, Technical Papers. Part 2 . New York, American Institute of Aeronautics and Astronautics, 1986, p. 178-191. refs

(Contract NAG2-209)

(AIAA PAPER 86-0865)

This paper presents a novel technique for formulating a high quality finite state unsteady aerodynamic model by applying Bode plot methods, used in control engineering. Indicial response functions for both fixed wing and rotary wing applications are obtained using these finite state unsteady aerodynamic models. It is shown that the rotary wing indicial response function has a fundamentally different characteristic when compared to fixed wing indicial response. The rotary wing indicial response function is oscillatory in nature while the fixed wing indicial response function is nonoscillatory. Furthermore it should be emphasized that this is the first that a rotary-wing indicial response function has been presented in the literature. Author

A86-38901#
A CALCULATION METHOD FOR UNSTEADY AERODYNAMIC FORCES IN THE LAPLACE DOMAIN AND ITS APPLICATION TO ROOT LOCI
T. UEDA (National Aerospace Laboratory, Chofu, Japan) IN: Structures, Structural Dynamics and Materials Conference, 27th, San Antonio, TX, May 19-21, 1986, Technical Papers. Part 2 . New York, American Institute of Aeronautics and Astronautics, 1986, p. 192-200. refs
(AIAA PAPER 86-0866)
A method for obtaining unsteady aerodynamic forces acting on a subsonic thin finite wing is presented. The unsteady forces are numerically evaluated as a function of the Laplace transform variable s which corresponds to arbitrary, as well as harmonic, motion of a wing. Computation is possible on the entire s-plane except for a branch cut on the negative real axis. The method proposed is based on the doublet point method so that the wing planform may be arbitrary including practical control surfaces. The exact forces obtained for the Laplace variable are applied to determine root loci of a wind tunnel wing model. Comparison of the results with those by the finite state aerodynamic modeling shows good accuracy of Roger's approximation. The effect of compressibility is also examined to reveal that the aerodynamic root does exist for a high subsonic flow range. Author

A86-38912#
AN EXPERIMENTAL STUDY OF THE AERODYNAMICS OF INCIPIENT TORSIONAL STALL FLUTTER
F. O. CARTA and P. F. LORBER (United Technologies Research Center, East Hartford, CT) IN: Structures, Structural Dynamics and Materials Conference, 27th, San Antonio, TX, May 19-21, 1986, Technical Papers. Part 2 . New York, American Institute of Aeronautics and Astronautics, 1986, p. 303-313. refs
(AIAA PAPER 86-0901)
An experimental study has been made of the aerodynamics of small amplitude airfoil torsional oscillations near stall to examine the mechanism that leads to stall flutter on propeller blades. An airfoil was oscillated in pitch at amplitudes of 0.5, 2.0, and 4.0 deg. Time histories of the unsteady surface pressures show that stall initiation and reattachment at low amplitudes are determined not only by kinematic conditions but also by the presence or absence of random effects such as gusts or vibrations. In contrast to the results at higher amplitude, hysteresis loops at low amplitude near stall are dominated by a central destabilizing subloop, so that the aerodynamic pitch damping per unit amplitude has a maximum negative value near an amplitude of 2 deg. This implies that small amplitude oscillations near stall may be extremely unstable. The measured aerodynamic damping is used in a model calculation to predict the growth rate of torsional oscillations of an airfoil free to oscillate in pitch. An initial small torsional disturbance grows rapidly and then asymptotically approaches a limiting amplitude, similar to behavior observed during stall flutter. Author

A86-38913*# Purdue Univ., West Lafayette, Ind.
A COMPUTATIONAL TRANSONIC FLUTTER BOUNDARY TRACKING PROCEDURE
J. W. GALLMAN, T. Y. YANG (Purdue University, West Lafayette, IN), and J. T. BATINA (NASA, Langley Research Center, Hampton, VA) IN: Structures, Structural Dynamics and Materials Conference, 27th, San Antonio, TX, May 19-21, 1986, Technical Papers. Part 2 . New York, American Institute of Aeronautics and Astronautics, 1986, p. 314-324. refs
(Contract NAG1-372)
(AIAA PAPER 86-0902)
An automated flutter boundary tracking procedure is presented for the efficient calculation of transonic flutter boundaries. The new procedure uses aeroelastic responses to march along the boundary by taking steps in speed and Mach number, thereby reducing the number of response calculations previously required to determine a transonic flutter boundary. The tracking procedure reduces computational costs since only two response calculations are required per Mach number and provides a complete boundary in a single job submission. Flutter boundary results are presented for a typical airfoil section oscillating with pitch and plunge degrees of freedom. These transonic flutter boundaries are in good agreement with 'exact' boundaries calculated using the conventional time-marching method. The tracking procedure was also extended to include static aeroelastic twist as a simulation of the static deformation of a wing and thus contains all of the essential features that are required to apply it to practical three-dimensional cases. Application of the procedure is also made to flutter boundaries as a function of structural parameters, the capability of which is useful as a design tool. Author

A86-38948*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
TRANSONIC AEROELASTICITY OF WINGS WITH TIP STORES
G. P. GURUSWAMY (Sterling Software/Informatics, Palo Alto, CA), P. M. GOORJIAN (NASA, Ames Research Center, Moffett Field, CA), and E. L. TU IN: Structures, Structural Dynamics and Materials Conference, 27th, San Antonio, TX, May 19-21, 1986, Technical Papers. Part 2 . New York, American Institute of Aeronautics and Astronautics, 1986, p. 672-683. USAF-supported research. refs
(AIAA PAPER 86-1007)
The presence of tip stores influences both aerodynamic and aeroelastic performances of wings. Such effects are more pronounced in the transonic regime. In this study, transonic aeroelasticity of wings with tip stores is studied for the first time by a theoretical method using the unsteady-small disturbance transonic aerodynamic equations coupled with modal structural equations of motion. The aerodynamic and structural equations of motion are simultaneously integrated by a time-accurate numerical scheme. To validate the tip store simulation, aeroelastic computations are made for a typical rectangular wing with a tip store and results are correlated with available wind tunnel data for the corresponding wing without a tip store at various flight conditions. Aeroelastic computations are also made for a typical fighter wing with a tip store. Present computations show that it is important to account for the aerodynamics of the tip store, particularly in the transonic regime where the tip store can make the wing aeroelastically unstable. Author

A86-38971
THE INDIRECT BOUNDARY INTEGRAL FORMULATION FOR ELLIPTIC, HYPERBOLIC AND NON-LINEAR FLUID FLOWS
B. HUNT and B. L. HEWITT (British Aerospace, PLC, Aircraft Group, Preston, England) IN: Developments in boundary element methods - 4 . London and New York, Elsevier Applied Science Publishers, 1986, p. 227-339. refs
Three distinct aspects of the boundary integral method for fluid flows are examined in detail. The fundamental physics are discussed first, showing how one of the practical boundary integral models employed in routine aerodynamic applications for incompressible irrotational flows may be interpreted in purely physical terms. Then, a detailed mathematical analysis of the linearized elliptic formulation is given which leads to the so-called 'indirect' boundary integral formulation permitting source and vorticity distributions of very low order to be used to give accurate by economical solutions. Finally, an extensive discussion of the linearized hyperbolic flow problem indicates how methodologies have been developed which allow boundary integral formulations to be successfully applied to the hyperbolic flow problem. C.D.

A86-39052#
UNSTEADY VORTICAL FLOW AROUND THREE-DIMENSIONAL LIFTING SURFACES
M. GAD-EL-HAK (Flow Research Co., Kent, WA) and C.-M. HO (Southern California, University, Los Angeles, CA) AIAA Journal (ISSN 0001-1452), vol. 24, May 1986, p. 713-721. Previously cited in issue 07, p. 836, Accession no. A85-19476. refs
(Contract F49620-82-C-0020)

A86-39053*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
COMPUTATION OF TRANSONIC FLOW ABOUT HELICOPTER ROTOR BLADES
R. ARIELI, M. E. TAUBER (NASA, Ames Research Center, Moffett Field, CA), D. A. SAUNDERS (Informatics General Corp., Palo Alto, CA), and D. A. CAUGHEY (Cornell University, Ithaca, NY) AIAA Journal (ISSN 0001-1452), vol. 24, May 1986, p. 722-727. refs

An inviscid, nonconservative, three-dimensional full-potential flow code, ROT22, has been developed for computing the quasi-steady flow about a lifting rotor blade. The code is valid throughout the subsonic and transonic regime. Calculations from the code are compared with detailed laser velocimeter measurements made in the tip region of a nonlifting rotor at a tip Mach number of 0.95 and zero advance ratio. In addition, comparisons are made with chordwise surface pressure measurements obtained in a wind tunnel for a nonlifting rotor blade at transonic tip speeds at advance ratios from 0.40 to 0.50. The overall agreement between theoretical calculations and experiment is very good. A typical run on a CRAY X-MP computer requires about 30 CPU seconds for one rotor position at transonic tip speed. Author

A86-39054#
A METHOD FOR THE DESIGN OF SHOCK-FREE SLENDER BODIES OF REVOLUTION
A. A. HASSAN (Arizona State University, Tempe) AIAA Journal (ISSN 0001-1452), vol. 24, May 1986, p. 728-734. refs

A numerical procedure is presented for the design of shock-free supercritical slender bodies of revolution. The procedure relies on the fact that for small disturbances a hodograph-like transformation (not known a priori) can be applied to the axisymmetric potential equation. This results in a set of two coupled Poisson equations defined on a common rectangular domain. With the special variables used, the system of coupled equations for the subsonic portion of the flow is solved iteratively using a fast Poisson solver. This in turn, defines the mapping of the subsonic or subsonic-sonic boundary in the physical plane. For supercritical flows, the supersonic portion of the flow is calculated from data on the sonic line using an axisymmetric characteristic calculation. This is followed by a map to the physical plane to determine the shape of the body under the sonic bubble. Examples of shock-free supercritical slender body designs are presented and show good agreement with the direct computation of the flow past the designed slender bodies. Author

A86-39090*# United Technologies Research Center, East Hartford, Conn.
THREE-DIMENSIONAL INVISCID FLOW IN MIXERS. I - MIXER ANALYSIS USING A CARTESIAN GRID
T. J. BARBER (United Technologies Research Center, East Hartford, CT), G. L. MULLER, S. M. RAMSAY (United Technologies Corp., Pratt and Whitney, East Hartford, CT), and E. M. MURMAN (MIT, Cambridge, MA) Journal of Propulsion and Power (ISSN 0748-4658), vol. 2, May-June 1986, p. 275-281. Previously cited in issue 07, p. 837, Accession no. A85-19510. refs
(Contract NAS3-23039)

A86-39657
HEAT TRANSFER AND DRAG OF A BODY IN THE FAR SUPERSONIC WAKE [TEPLOOBMEN I SOPROTIVLENIE TELA, RASPOLOZHENNOGO V DAL'NEM SVERKHZVUKOVOM SLEDE]
I. G. EREMEITSEV and N. N. PILIUGIN Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), Mar.-Apr. 1986, p. 60-67. In Russian. refs

Generalized formulas are obtained which provide a convenient way to make mass calculations of convective heat fluxes toward bodies and their drag in wake-type inhomogeneous flows. Attention is also given to the formation of a return-circulation zone at the frontal surface of the body. A comparison of the results obtained with real parameters of a far wake has shown that the nonseparated flow region is sufficiently large. The effect of flow inhomogeneity on the local and integral flow characteristics is examined. V.L.

A86-39660
LIFTING BODIES DESIGNED FOR FLOW BEHIND AXISYMMETRIC CONICAL SHOCK WAVES [NESUSHCHIE TELA, POSTROENNYE NA TECHENIIA ZA OSESIMMETRICHNYMI KONICHESKIMI SKACHKAMI UPLOTNENIIA]
V. I. VORONIN and A. I. SHVETS Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), Mar.-Apr. 1986, p. 135-138. In Russian.

A numerical solution is presented for the problem of flow past lifting bodies designed for flow behind axisymmetric conical shock waves with half-angles of taper of 9.5 and 18 deg. The leading edge of the bodies considered here is located below the apex of the conical shock wave; the upper surfaces of the bodies are formed by intersecting planes parallel to the velocity vector of the oncoming flow. The solution presented here has been implemented in computer software. Results of calculations are presented in graphic form. V.L.

A86-39762#
RECURRENT IDENTIFICATION OF UNSTEADY AERODYNAMIC FORCES OF ELASTIC VEHICLES
X. XIONG (Northwestern Polytechnical University, Xian, People's Republic of China) Acta Aeronautica et Astronautica Sinica, vol. 7, April 1986, p. 121-127. In Chinese, with abstract in English.

A method for identifying the unsteady aerodynamic forces of elastic vehicles is presented. A standard measurement equation satisfied by aerodynamic indicial functions is derived from longitudinal small-disturbance equations of elastic vehicles with unsteady aerodynamic forces described by Duhamel's integral. The discrete values of aerodynamic indicial functions in time domain are obtained by using the recurrent filter technique. In comparison with other methods, this method has the following advantages: (1) the ability to take the effects of structural deformation into account; (2) the capability to identify the unsteady aerodynamic parameters of the whole vehicle; (3) ease in collecting initial data; and (4) simplicity of calculations. Finally, some results of the preliminary calculation for a vehicle are given. Author

N86-26285*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
PLUME CHARACTERISTICS OF SINGLE-STREAM AND DUAL-FLOW CONVENTIONAL AND INVERTED-PROFILE NOZZLES AT EQUAL THRUST
U. H. VONGLAHN and J. H. GOODYKOONTZ 1986 39 p refs Presented at the 4th Applied Aerodynamics Conference, San Diego, Calif. 9-11 Jun. 1986; sponsored by AIAA
(NASA-TM-87323; E-3060; NAS 1.15:87323; AIAA-86-1809)
Avail: NTIS HC A03/MF A01 CSCL 01A

The plume velocity and temperature decay rates of single-stream, conventional dual-flow and inverted-profile dual-flow nozzles are compared at equal values of ideal thrust over a wide range of flow conditions. The comparisons are made in terms of constant velocity and temperature contour maps. The results show that both dual-flow nozzle types have much greater plume velocity and temperature decay rates than those of equivalent thrust single-stream nozzles when the respective secondary flows were at ambient temperature. With hot secondary flows, the inverted-profile dual-flow plumes decayed significantly faster than those of single-stream nozzles; however, the decay rates for the conventional dual-flow streams were about the same as those for the single-stream nozzles. Consequently, with hot secondary flows, the inverted-profile dual-flow plumes decayed much faster than the conventional dual-flow plumes at equal thrust. Author

N86-26288*# United Technologies Research Center, East Hartford, Conn.

ANALYSIS OF TRANSITIONAL SEPARATION BUBBLES ON INFINITE SWEPT WINGS

R. L. DAVIS and J. E. CARTER Washington Jun. 1986 39 p refs

(Contract NAS1-16585)

(NASA-CR-3956; NAS 1.26:3956) Avail: NTIS HC A03/MF A01 CSCL 01A

A previously developed two-dimensional local inviscid-viscous interaction technique for the analysis of airfoil transitional separation bubbles, ALESEP (Airfoil Leading Edge Separation), has been extended for the calculation of transitional separation bubbles over infinite swept wings. As part of this effort, Roberts' empirical correlation, which is interpreted as a separated flow empirical extension of Mack's stability theory for attached flows, has been incorporated into the ALESEP procedure for the prediction of the transition location within the separation bubble. In addition, the viscous procedure used in the ALESEP techniques has been modified to allow for wall suction. A series of two-dimensional calculations is presented as a verification of the prediction capability of the interaction techniques with the Roberts' transition model. Numerical tests have shown that this two-dimensional natural transition correlation may also be applied to transitional separation bubbles over infinite swept wings. Results of the interaction procedure are compared with Horton's detailed experimental data for separated flow over a swept plate which demonstrates the accuracy of the present technique. Wall suction has been applied to a similar interaction calculation to demonstrate its effect on the separation bubble. The principal conclusion of this paper is that the prediction of transitional separation bubbles over two-dimensional or infinite swept geometries is now possible using the present interacting boundary layer approach. Author

N86-26289*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

TABLES FOR CORRECTING AIRFOIL DATA OBTAINED IN THE LANGLEY 0.3-METER TRANSONIC CRYOGENIC TUNNEL FOR SIDEWALL BOUNDARY-LAYER EFFECTS

R. V. JENKINS and J. B. ADCOCK Jun. 1986 16 p refs

(NASA-TM-87723; NAS 1.15:87723) Avail: NTIS HC A02/MF A01 CSCL 01A

Tables for correcting airfoil data taken in the Langley 0.3-meter Transonic Cryogenic Tunnel for the presence of sidewall boundary layer are presented. The corrected Mach number and the correction factor are minutely altered by a 20 percent change in the boundary layer virtual origin distance. The sidewall boundary layer displacement thicknesses measured for perforated sidewall inserts and without boundary layer removal agree with the values calculated for solid sidewalls. Author

N86-26291# Woodrow Wilson International Center for Scholars, Washington, D.C. Asia Program.

THE EFFECTS ON ROTOR NONUNIFORM INFLOW HARMONIC CONTENT OF UNEVEN CIRCUMFERENTIAL DISTRIBUTION OF JET ENGINE INLET GUIDE VANES

M. R. HINSMAN Jan. 1986 39 p refs

(Contract N00024-85-C-6041)

(AD-A164629) Avail: NTIS HC A03/MF A01 CSCL 20D

A computative parametric study was conducted to investigate the effects of vane section geometry, vane number, and primarily, uneven circumferential vane spacing on the harmonic content of the wake field produced by a row of jet engine inlet guide vanes (IGV). As parameters were varied, the harmonic content of the resulting wake field was analyzed for its potential effect on unsteady pressures at the rotor. A semi-empirical model is presented which was used to generate the two-dimensional flow field downstream of the IGV plane. Results show that uneven angular spacing of IGV should not be employed for reducing unsteady pressures experienced by the rotor. In fact, manufacturing tolerances, relative to IGV angular location, of evenly spaced vanes should be minimized to minimize unsteady pressures. GRA

N86-26293# National Aerospace Lab., Amsterdam (Netherlands). Fluid Dynamics Div.

LAMINAR AND TURBULENT BOUNDARY-LAYER CALCULATIONS ON THE LEEWARD SURFACE OF A SLENDER DELTA WING AT INCIDENCE

A. C. DEBRUIN 13 Apr. 1984 20 p Submitted for publication

(NLR-MP-84040-U; B8577053; ESA-86-96969) Avail: NTIS HC A02/MF A01

The boundary layer on the leeward surface of a slender delta wing at incidence was calculated for fully laminar flow and the case with artificial boundary layer tripping at the 50% semispan location. The behavior of the predicted boundary layer properties is qualitatively in good agreement with experimental observations. The rather large difference between the potential flow and experimental pressure distribution causes a discrepancy between the predicted and the experimentally observed location of secondary separation. It is expected that the potential flow pressure distribution can be improved when the leading-edge and the secondary separation vortex sheet are correctly modeled in the potential flow calculation method. ESA

N86-27182*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

UNSTEADY AERODYNAMICS-FUNDAMENTALS AND APPLICATIONS TO AIRCRAFT DYNAMICS

D. G. MABEY (Royal Aircraft Establishment, Bedford, England) and J. R. CHAMBERS 1985 18 p

(NASA-TM-88768; NAS 1.15:88768; AGARD-AR-222; ISBN-92-835-1515-3) Avail: NTIS HC A02/MF A01 CSCL 01A

From May 6 to 9, 1985, the Fluid Dynamics Panel and Flight Mechanics Panel of AGARD jointly arranged a Symposium on Unsteady Aerodynamics-Fundamentals and Applications to Aircraft Dynamics at the Stadthall, Gottingen, West Germany. This Symposium was organized by an international program committee chaired by Dr K. J. Orlik-Ruckemann of the Fluid Dynamics Panel. The program consisted of five sessions grouped in two parts: (1) Fundamentals of Unsteady Aerodynamics; and (2) Applications to Aircraft Dynamics. The 35 papers presented at the 4 day meeting are published in AGARD CP 386 and listed in the Appendix. As the papers are already available and cover a very wide field, the evaluators have offered brief comments on every paper, followed by an overall evaluation of the meeting, together with some general conclusions and recommendations. Author

N86-27184# National Aerospace Lab., Tokyo (Japan). Second Aerodynamics Div.

COMPUTATION OF 3-DIMENSIONAL VISCOUS TRANSONIC FLOWS USING THE LU-ADI FACTORED SCHEME

K. FUJII and S. OBAYASHI Nov. 1985 20 p

(NAL-TR-889T; ISSN-0389-4010) Avail: NTIS HC A02/MF A01

The LU-ADI (lower/upper block diagonal - alternating direction implicit) factored scheme was successfully applied to solve the three-dimensional compressible thin layer Navier-Stokes equations. The computations are carried out for the slightly supersonic flow over a hemispheric cylinder at high incidence and for the transonic flow over a swept wing. To simulate these complicated flow fields, fine grid distributions of up to about 200,000 points were used on the Japanese supercomputer of 1 GFLOPS. The total cpu time for each case was less than two hours. The results for the flow over a hemispheric cylinder at high incidence revealed the existence of the shock wave and the detailed structure of the vortical flow field on the leeward side. The result for the flow over the swept wing shows that the three-dimensional shock induced separation is well captured. These results indicate the capability of the present code to make three-dimensional complicated flow field simulations; and the application of the present code to the more practical flow fields such as transonic flows over the wing or the wing-body combination of the transportation aircraft is very promising. Even simulation over the whole aircraft may soon be possible. Author

N86-27185# National Aerospace Lab., Tokyo (Japan).
WIND TUNNEL TEST AND ANALYSIS ON GUST LOAD ALLEVIATION OF A HIGH-ASPECT-RATIO WING
Nov. 1985 60 p In JAPANESE; ENGLISH summary
(NAL-TR-890; ISSN-0389-4010) Avail: NTIS HC A04/MF A01

Application of the active control technology to gust load alleviation problems was investigated both experimentally and analytically. Wind tunnel test were conducted for a high aspect ratio wing that assumes an energy efficient type of future transport. For these tests, National Aerospace Laboratory's low speed wind tunnel was equipped with a gust generator with hydraulic servo system. This generator generates turbulence by utilizing the tip vortices from the cantilevered double wings. Atmospheric turbulence was simulated in the tunnel according to the Dryden mathematical model. Control surfaces of the flexible wing model were actuated by a small dc electric motor embedded in the airfoil. A handy analog computer played the role of controller to drive control surfaces by the signals from two accelerometers and a strain gauge which was installed in the model as feedback sensors. Control laws were obtained by the optimal control theory with its performance index selected as the total energy of the system. Simple control laws based on the LQG theory demonstrated their effectiveness against realistic random gusts. At the end of the test, the flutter boundary of this model was determined for the configuration without active control. Author

N86-27187# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Fluid Dynamics Panel.
AIRCRAFT DRAG PREDICTION AND REDUCTION. ADDENDUM 1: COMPUTATIONAL DRAG ANALYSES AND MINIMIZATION; MISSION IMPOSSIBLE?
J. W. SLOOFF (National Aerospace Lab., Amsterdam, Netherlands) Apr. 1986 33 p Presented at Aircraft Drag Prediction and Reduction, Rhode Saint Genese, Belgium, 20-23 May 1985, and Hampton, Va., 5-8 Aug. 1985; sponsored by the von Karman Inst., AGARD, and NASA Langley Research Center
(AGARD-R-723-ADD-1; ISBN-92-835-1524-2) Avail: NTIS HC A03/MF A01

The Special Course on Aircraft Drag Prediction was sponsored by the AGARD Fluid Dynamics Panel and the von Karman Institute and presented at the von Karman Institute, Rhode-Saint-Genese, Belgium, on 20 to 23 May 1985 and at the NASA Langley Research Center, Hampton, Virginia, USA, 5 to 6 August 1985. The course began with a general review of drag reduction technology. Then the possibility of reduction of skin friction through control of laminar flow and through modification of the structure of the turbulence in the boundary layer were discussed. Methods for predicting and reducing the drag of external stores, of nacelles, of fuselage protuberances, and of fuselage afterbodies were then presented followed by discussion of transonic drag rise. The prediction of viscous and wave drag by a method matching inviscid flow calculations and boundary layer integral calculations, and the reduction of transonic drag through boundary layer control are also discussed. This volume comprises Paper No.9 Computational Drag Analyses and Minimization: Mission Impossible? which was not included in AGARD Report 723 (main volume). Author

N86-27190*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
VORTEX FLOW AERODYNAMICS, VOLUME 1
J. F. CAMPBELL, ed., R. F. OSBORN, ed. (Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio), and J. T. FOUGHNER, JR., ed. Jul. 1986 404 p Conference held in Hampton, Va., 8-10 Oct. 1985
(NASA-CP-2416-VOL-1; L-16117; NAS 1.55:2416-VOL-1) Avail: NTIS HC A18/MF A01 CSCL 01A

Vortex modeling techniques and experimental studies of research configurations utilizing vortex flows are discussed. Also discussed are vortex flap investigations using generic and airplane research models and vortex flap theoretical analysis and design studies.

N86-27191*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
VORTEX LIFT RESEARCH: EARLY CONTRIBUTIONS AND SOME CURRENT CHALLENGES
E. C. POLHAMUS *In its* Vortex Flow Aerodynamics, Vol. 1 p 1-30 Jul. 1986
Avail: NTIS HC A18/MF A01 CSCL 01A

The trend towards slender wing aircraft for supersonic cruise and the early chronology of research directed towards their vortex-lift characteristics are briefly reviewed. An overview of the development of vortex-lift theoretical methods is presented, and some current computational and experimental challenges related to the viscous flow aspects of this vortex flow are discussed. Author

N86-27192*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
LEADING-EDGE VORTEX RESEARCH: SOME NONPLANAR CONCEPTS AND CURRENT CHALLENGES
J. F. CAMPBELL and R. F. OSBORN (Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio) *In its* Vortex Flow Aerodynamics, Vol. 1 p 31-63 Jul. 1986
Avail: NTIS HC A18/MF A01 CSCL 01A

Some background information is provided for the Vortex Flow Aerodynamics Conference and that current slender wing airplanes do not use variable leading edge geometry to improve transonic drag polar is shown. Highlights of some of the initial studies combining wing camber, or flaps, with vortex flow are presented. Current vortex flap studies were reviewed to show that there is a large subsonic data base and that transonic and supersonic generic studies have begun. There is a need for validated flow field solvers to calculate vortex/shock interactions at transonic and supersonic speeds. Many important research opportunities exist for fundamental vortex flow investigations and for designing advanced fighter concepts. Author

N86-27193*# Kansas Univ., Lawrence. Dept. of Aerospace Engineering.
EXTENSIONS OF THE CONCEPT OF SUCTION ANALOGY TO PREDICTION OF VORTEX LIFT EFFECT
C. E. LAN *In* NASA. Langley Research Center Vortex Flow Aerodynamics, Vol. 1 p 65-84 Jul. 1986
(Contract NSG-1629)
Avail: NTIS HC A18/MF A01 CSCL 01A

Flow field data for a double delta wing at low speed were used to determine the location of a vortex action point. The result was found to be consistent with what was determined for a delta wing. In supersonic flow, the action point location was determined empirically. For a wing with rounded leading edges, an assumption for initial vortex separation was shown to be equivalent to initial leading edge bubble separation for airfoils. A theoretical formulation by the section analogy to determine the delayed vortex separation on a cambered wing with rounded leading edges was presented. The method of suction analogy was further shown to be applicable to predicting the body vortex lift. Author

N86-27194*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
RECENT EXTENSIONS TO THE FREE-VORTEX-SHEET THEORY FOR EXPANDED CONVERGENCE CAPABILITY
J. M. LUCKRING, K. D. HOFFLER (Vigyan Research Associates, Inc., Hampton, Va.), and A. C. GRANTZ (Northrop Corp., Hawthorne, Calif.) *In its* Vortex Flow Aerodynamics, Vol. 1 p 85-114 Jul. 1986
Avail: NTIS HC A18/MF A01 CSCL 01A

A new version of the free vortex sheet formulation is presented which has greatly improved convergence characteristics for a broad range of geometries. The enhanced convergence properties were achieved largely with extended modeling capabilities of the leading edge vortex and the near field trailing wake. Results from the new code, designated FVS-1, are presented for a variety of configurations and flow conditions with emphasis on vortex flap applications. Author

N86-27195*# North Carolina State Univ., Raleigh.
A DIRECT AND INVERSE BOUNDARY LAYER METHOD FOR SUBSONIC FLOW OVER DELTA WINGS
S. H. WOODSON and F. R. DEJARNETTE *In* NASA. Langley Research Center Vortex Flow Aerodynamics, Vol. 1 p 115-133 Jul. 1986
(Contract NCC1-22)
Avail: NTIS HC A18/MF A01 CSCL 01A

A new inverse boundary layer method is developed and applied to incompressible flows with laminar separation and reattachment. Test cases for two dimensional flows are computed and the results are compared with those of other inverse methods. One advantage of the present method is that the calculation of the inviscid velocities may be determined at each marching step without having to iterate. The inverse method was incorporated with the direct method to calculate the incompressible, conical flow over a slender delta wing at incidence. The location of the secondary separation line on the leeward surface of the wing is determined and compared with experiment for a unit aspect ratio wing at 20.5 deg incidence. The viscous flow in the separated region was calculated using prescribed skin friction coefficients. Author

N86-27196*# Notre Dame Univ., Ind.
AN EXPERIMENTAL INVESTIGATION OF VORTEX BREAKDOWN ON A DELTA WING
F. M. PAYNE and R. C. NELSON *In* NASA. Langley Research Center Vortex Flow Aerodynamics, Vol. 1 p 135-161 Jul. 1986
(Contract NAG2-258)
Avail: NTIS HC A18/MF A01 CSCL 01A

An experimental investigation of vortex breakdown on delta wings at high angles is presented. Thin delta wings having sweep angles of 70, 75, 80 and 85 degrees are being studied. Smoke flow visualization and the laser light sheet technique are being used to obtain cross-sectional views of the leading edge vortices as they break down. At low tunnel speeds (as low as 3 m/s) details of the flow, which are usually imperceptible or blurred at higher speeds, can be clearly seen. A combination of lateral and longitudinal cross-sectional views provides information on the three dimensional nature of the vortex structure before, during and after breakdown. Whereas details of the flow are identified in still photographs, the dynamic characteristics of the breakdown process were recorded using high speed movies. Velocity measurements were obtained using a laser Doppler anemometer with the 70 degree delta wing at 30 degrees angle of attack. The measurements show that when breakdown occurs the core flow transforms from a jet-like flow to a wake-like flow. Author

N86-27197*# Lockheed-Georgia Co., Marietta.
LASER VELOCIMETRY IN HIGHLY THREE-DIMENSIONAL AND VORTICAL FLOWS
C. J. NOVAK, C. R. HUIE, and K. C. CORNELIUS *In* NASA. Langley Research Center Vortex Flow Aerodynamics, Vol. 1 p 163-185 Jul. 1986
Avail: NTIS HC A18/MF A01 CSCL 01A

The need for experimentally determined 3-D velocity information is crucial to the understanding of highly 3-dimensional and vortical flow fields. In addition to gaining an understanding of the physics of flow fields, a correlation of velocity data is needed for advanced computational modelling. A double pass method for acquiring 3-D flow field information using a 2-D laser velocimeter (LV) is described. The design and implementation of a 3-D LV with expanded capabilities to acquire real-time 3-D flow field information are also described. Finally, the use of such an instrument in a wind tunnel study of a generic fighter configuration is described. The results of the wind tunnel study highlight the complexities of 3-D flow fields, particularly when the vortex behavior is examined over a range of angles of attack. Author

N86-27198*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
IN-FLIGHT AND WIND TUNNEL LEADING-EDGE VORTEX STUDY ON THE F-106B AIRPLANE
J. E. LAMAR *In its* Vortex Flow Aerodynamics, Vol. 1 p 187-201 Jul. 1986
Avail: NTIS HC A18/MF A01 CSCL 01A

The vapor screen technique was successfully applied to an F-106B fighter aircraft during subsonic and transonic maneuvers. This system has allowed the viewing of multiple vortex systems on the wing upper surface at angles of attack less than 19 deg. In addition, similarities as well as differences were determined to exist between the vortex systems for a full scale semispan model and the flight vehicle at 20 deg incidence. Furthermore, variations in Reynolds number and Mach number were identified as to how they affect vortex system details at flight conditions. Author

N86-27199*# Vigyan Research Associates, Inc., Hampton, Va.
BASIC STUDIES ON DELTA WING FLOW MODIFICATIONS BY MEANS OF APEX FENCES
K. D. HOFFLER, D. M. RAO, and M. C. FRASSINELLI (Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio) *In* NASA. Langley Research Center Vortex Flow Aerodynamics, Vol. 1 p 203-217 Jul. 1986
Avail: NTIS HC A18/MF A01 CSCL 01A

The effectiveness of apex fences on a 60-deg delta wing at low speeds was experimentally investigated. Resembling highly swept spoilers in appearance, the fences are designed to fold out of the wing apex region upper surface near the leading edges, where they generate a powerful vortex pair. The intense suction of the fence vortices augments lift in the apex region, the resulting positive pitching moment being utilized to trim trailing edge flaps for lift augmentation during approach and landing at relatively low angles of attack. The fences reduce the apex lift at high angles of attack, leading to a desirable nose-down moment. The above projected functions of the apex fence device were validated and quantified through low speed tunnel tests, comprising upper surface pressure surveys on a semispan model and balance measurements on a geometrically similar fully span wing/body configuration. Fence parameters such as area, shape, hinge position and deflection angle were investigated. Typical results are presented indicating the apex fence potential in controlling the longitudinal characteristics of a tail-less delta. Author

N86-27200*# Vigyan Research Associates, Inc., Hampton, Va.
TOWARDS AN ADVANCED VORTEX FLAP SYSTEM: THE CAVITY FLAP
D. M. RAO *In* NASA. Langley Research Center Vortex Flow Aerodynamics, Vol. 1 p 219-230 Jul. 1986
Avail: NTIS HC A18/MF A01 CSCL 01A

An extension of the vortex flap concept was explored with the aim of providing high-alpha flight control capability coupled with maneuver drag reduction for highly swept wing configurations. A retractable lower surface flap mounted on a translating hinge is proposed, allowing chordwise extension as well as deflection, the two movements being independently controlled. The frontal cavity formed by the partially extended and deflected flap captures a vortex above a certain angle of attack. The cavity vortex downwash alleviates the effective incidence of the wing leading edge, thus modulating vortex lift; at the same time, the induced suction in the cavity generates thrust. These postulated aerodynamic features of the cavity flap were validated through low speed tunnel pressure and visualization tests on a 65 deg swept oblique wing model, which also provided initial trends of the leading edge vortex alleviation and cavity suction with respect to flap extension, deflection and angle of attack. Force tests on a 60 deg delta model further showed the cavity flap L/D performance to compare favorably with the conventional vortex flap. A two segment flap arrangement with independently control led segments was envisaged for exploiting the vortex modulation capability of the cavity flap for pitch, roll and yaw control, in addition to drag reduction at high angles of attack. Author

N86-27201*# General Dynamics Corp., Fort Worth, Tex.
VORTEX FLOW HYSTERESIS
A. M. CUNNINGHAM, JR. *In* NASA. Langley Research Center Vortex Flow Aerodynamics, Vol. 1 p 231-248 Jul. 1986
Avail: NTIS HC A18/MF A01 CSCL 01A

An experimental study was conducted to quantify the hysteresis associated with various vortex flow transition points and to determine the effect of planform geometry. The transition points observed consisted of the appearance (or disappearance) of trailing edge vortex burst and the transition to (or from) flat plate or totally separated flows. Flow visualization with smoke injected into the vortices was used to identify the transitions on a series of semi-span models tested in a low speed tunnel. The planforms tested included simple deltas (55 deg to 80 deg sweep), cranked wings with varying tip panel sweep and dihedral, and a straked wing. High speed movies at 1000 frames per second were made of the vortex flow visualization in order to better understand the dynamics of vortex flow, burst and transition. Author

N86-27202*# Boeing Military Airplane Development, Seattle, Wash.
VISCOUS VORTICAL FLOW CALCULATIONS OVER DELTA WINGS
G. BLOM, J. C. WAI, and H. YOSHIHARA *In* NASA. Langley Research Center Vortex Flow Aerodynamics, Vol. 1 p 249-261 Jul. 1986
Avail: NTIS HC A18/MF A01 CSCL 01A

Two approaches to calculate turbulent vortical flows over delta wing configurations are illustrated. The first is for a simple delta wing at low speeds using the boundary layer approximation to treat the effects of the secondary separation. The second is for the supersonic case of a generic fighter using the NASA Ames parabolized Navier/Stokes method. Test/theory comparisons are given in both cases. Author

N86-27203*# Lockheed-California Co., Burbank.
AN EULER AERODYNAMIC METHOD FOR LEADING-EDGE VORTEX FLOW SIMULATION
P. RAJ and L. N. LONG (Lockheed-Advanced Aeronautics Co., Valencia, Calif.) *In* NASA. Langley Research Center Vortex Flow Aerodynamics, Vol. 1 p 263-281 Jul. 1986
Avail: NTIS HC A18/MF A01 CSCL 01A

The current capabilities and the future plans for a three dimensional Euler Aerodynamic Method are described. The basic solution algorithm is based on the finite volume, Runge-Kutta pseudo-time-stepping scheme of FLO-57. Several modifications to improve accuracy and computational efficiency were incorporated and others are being investigated. The computer code is used to analyze a cropped delta wing at 0.6 Mach number and an arrow wing at 0.85 Mach number. Computed aerodynamic parameters are compared with experimental data. In all cases, the configuration is impulsively started and no Kutta condition is applied at sharp edges. The results indicate that with additional development and validation, the present method will be a useful tool for engineering analysis of high speed aircraft. Author

N86-27205*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
COMPUTATION OF LEADING-EDGE VORTEX FLOWS
R. W. NEWSOME (Air Force Wright Aeronautical Labs., Hampton, Va.) and J. L. THOMAS *In its* Vortex Flow Aerodynamics, Vol. 1 p 305-330 Jul. 1986
Avail: NTIS HC A18/MF A01 CSCL 01A

The simulation of the leading edge vortex flow about a series of conical delta wings through solution of the Navier-Stokes and Euler equations is studied. The occurrence, the validity, and the usefulness of separated flow solutions to the Euler equations of particular interest. Central and upwind difference solutions to the governing equations are compared for a series of cross sectional shapes, including both rounded and sharp tip geometries. For the rounded leading edge and the flight condition considered, viscous solutions obtained with either central or upwind difference methods predict the classic structure of vortical flow over a highly swept delta wing. Predicted features include the primary vortex due to leading edge separation and the secondary vortex due to crossflow separation. Central difference solutions to the Euler equations show a marked sensitivity to grid refinement. On a coarse grid, the flow separates due to numerical error and a primary vortex which resembles that of the viscous solution is predicted. In contrast, the upwind difference solutions to the Euler equations predict attached flow even for first-order solutions on coarse grids. On a sufficiently fine grid, both methods agree closely and correctly predict a shock-curvature-induced inviscid separation near the leeward plane of symmetry. Upwind difference solutions to the Navier-Stokes and Euler equations are presented for two sharp leading edge geometries. The viscous solutions are quite similar to the rounded leading edge results with vortices of similar shape and size. The upwind Euler solutions predict attached flow with no separation for both geometries. However, with sufficient grid refinement near the tip or through the use of more accurate spatial differencing, leading edge separation results. Once the leading edge separation is established, the upwind solution agrees with recently published central difference solutions to the Euler equations. Author

N86-27206*# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.
STEADY SUPERSONIC NAVIER-STOKES SOLUTIONS OF A 75 DEG DELTA WING
T. A. BUTER and D. P. RIZZETTA *In* NASA. Langley Research Center Vortex Flow Aerodynamics, Vol. 1 p 331-347 Jul. 1986
Avail: NTIS HC A18/MF A01 CSCL 01A

Steady solutions about a slender sharp edged delta wing in a supersonic freestream for moderate and high angles of attack are obtained numerically by time integration of the unsteady compressible three dimensional laminar Navier-Stokes equations. The main features of the flow, including primary and secondary separation, and vortex position and strength, are adequately simulated in the numerical solutions. Improved resolution of the computational grid in the leading edge region from a previous solution had considerable effect on the accuracy of the solutions. Good agreement between numerical solutions and experimental data was obtained for two cases. A local timestepping procedure is used to speed convergence by approximately a factor of two. Author

N86-27207*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
AN OVERVIEW OF THE FUNDAMENTAL AERODYNAMICS BRANCH'S RESEARCH ACTIVITIES IN WING LEADING-EDGE VORTEX FLOWS AT SUPERSONIC SPEEDS
D. S. MILLER, R. M. WOOD, and P. F. COVELL *In its* Vortex Flow Aerodynamics, Vol. 1 p 349-377 Jul. 1986
Avail: NTIS HC A18/MF A01 CSCL 01A

For the past 3 years, a research program pertaining to the study of wing leading edge vortices at supersonic speeds has been conducted in the Fundamental Aerodynamics Branch of the High-Speed Aerodynamics Division at the Langley Research Center. The purpose of the research is to provide an understanding of the factors governing the formation and the control of wing leading-edge vortices and to evaluate the use of these vortices for improving supersonic aerodynamic performance. The studies include both experimental and theoretical investigations and focus primarily on planform, thickness and camber effects for delta wings. An overview of this research activity is presented. Author

N86-27208*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
WATER TUNNEL RESULTS OF LEADING-EDGE VORTEX FLAP TESTS ON A DELTA WING VEHICLE
J. H. DELFRATE *In* NASA. Langley Research Center Vortex Flow Aerodynamics, Vol. 1 p 379-389 Jul. 1986
Avail: NTIS HC A18/MF A01 CSCL 01A

A water tunnel flow visualization test on leading edge vortex flaps was conducted at the flow visualization facility of the NASA Ames Research Center's Dryden Flight Research Facility. The

purpose of the test was to visually examine the vortex structures caused by various leading edge vortex flaps on the delta wing of an F-106 model. The vortex flaps tested were designed analytically and empirically at the NASA Langley Research Center. The three flap designs were designated as full-span gothic flap, full-span untapered flap, and part-span flap. The test was conducted at a Reynolds number of 76,000/m (25,000/ft). This low Reynolds number was used because of the 0.076-m/s (0.25-ft/s) test section flow speed necessary for high quality flow visualization. However, this low Reynolds number may have influenced the results. Of the three vortex flaps tested, the part-span flap produced what appeared to be the strongest vortex structure over the flap area. The full-span gothic flap provided the next best performance. Author

N86-27209*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

EVALUATION OF 3 NUMERICAL METHODS FOR PROPULSION INTEGRATION STUDIES ON TRANSONIC TRANSPORT CONFIGURATIONS

S. F. YAROS, J. R. CARLSON, and B. CHANDRASEKARAN (Vigyan Research Associates, Inc., Hampton, Va.) Jun. 1986 23 p Presented at the 4th AIAA Applied Aerodynamics Conference, San Diego, Calif., 9-11 Jun. 1986

(NASA-TM-87727; NAS 1.15:87727; AIAA-86-1814) Avail: NTIS HC A02/MF A01 CSCL 01A

An effort has been undertaken at the NASA Langley Research Center to assess the capabilities of available computational methods for use in propulsion integration design studies of transonic transport aircraft, particularly of pylon/nacelle combinations which exhibit essentially no interference drag. The three computer codes selected represent state-of-the-art computational methods for analyzing complex configurations at subsonic and transonic flight conditions. These are: EULER, a finitie volume solution of the Euler equation; VSAERO, a panel solution of the Laplace equation; and PPW, a finite difference solution of the small disturbance transonic equations. In general, all three codes have certain capabilities that allow them to be of some value in predicting the flows about transport configurations, but all have limitations. Until more accurate methods are available, careful application and interpretation of the results of these codes are needed. Author

N86-27212# National Aeronautical Lab., Bangalore (India). Aerodynamics Div.

ANALYSIS OF WINGS WITH LEADING EDGE AND/OR TRAILING EDGE SEGMENTED (SPANWISE) FLAPS USING PLANAR HORSE SHOE VORTEX LATTICE METHOD

B. RAJESWARI and H. N. V. DUTT Nov. 1985 74 p

(NAL-TM-AE-8507) Avail: NTIS HC A04/MF A01

A method and a computer program in FORTRAN have been developed for the analysis of wings with segmented leading edge and trailing edge flaps using planar horse-shoe vortices. This computer program can be used to estimate overall aerodynamic characteristics like C sub L, C sub D and C sub M and the detailed local loads for a given wing flap geometry at specified incidence and Mach number. The method has no limitations on aspect ratio, taper ratio and sweep angles. The code has been validated for a number of cases for which experimental data is available. The program is working on UNIVAC 1100-60 computer and takes about 2 minutes to analyze a typical wing-flap configuration (with approximately 120 panels) for a given incidence and Mach number. Author

N86-27213*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

PRELIMINARY RESULTS OF UNSTEADY BLADE SURFACE PRESSURE MEASUREMENTS FOR THE SR-3 PROPELLER

L. J. HEIDELBERG and B. J. CLARK 1986 26 p Presented at the 10th Aeroacoustics Conference, Seattle, Wash., 9-11 Jul. 1986

(NASA-TM-87352; E-3106; NAS 1.15:87352; AIAA-86-1893) Avail: NTIS HC A03/MF A01 CSCL 01A

Unsteady blade surface pressures were measured on an advanced, highly swept propeller known as SR-3. These measurements were obtained because the unsteady aerodynamics of these highly loaded transonic blades is important to noise generation and aeroelastic response. Specifically, the response to periodic angle-of-attack change was measured for both two- and eight-bladed configurations over a range of flight Mach numbers from 0.4 to 0.85. The periodic angle-of-attack change was obtained by placing the propeller axis at angles up to 4 deg to the flow. Most of the results are presented in terms of the unsteady pressure coefficient variation with Mach number. Both cascade and Mach number effects were largest on the suction surface near the leading edge. The results of a three-dimensional Euler code applied in a quasi-steady fashion were compared to measured data at the reduced frequency of 0.1 and showed relatively poor agreement. Pressure waveforms are shown that suggest shock phenomena may play an important part in the unsteady pressure response at some blade locations. Author

N86-27217# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).

LA RECHERCHE AEROSPATIALE. BIMONTHLY BULLETIN, NO. 1984-6, NOVEMBER - DECEMBER 1984

C. SEVESTRE, ed. Paris ESA May 1985 59 p Transl. into ENGLISH of La Recherche Aerospatiale. Bulletin Bimensuel (Paris, France), no. 1984-6, Nov. - Dec. 1984 Original language document was announced in IAA as A84-37528

(ESA-TT-907; ESA-85-95383) Avail: NTIS HC A04/MF A01; HC also available in English and French from ONERA, Paris FF 70

Turbulence models for a separated three dimensional turbulent boundary layer; a vortex point method for calculation of inviscid incompressible flows around rotary wings; effect of Reynolds number on the aerodynamic characteristics of an ogive-cylinder at high angle of attack; a hybrid finite difference-spectral method for computing compressible fluid flows; modeling the dynamic stall of the NACA 0012 profile; and helicopter noise are discussed.

N86-27222# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).

DYNAMIC STALL MODELING OF THE NACA 0012 PROFILE

D. PETOT *In its* La Recherche Aerospatiale. Bimonthly Bulletin, no. 1984-6, November - December 1984 (ESA-TT-907) 4 p May 1985 Previously announced in IAA as A86-12024

Avail: NTIS HC A04/MF A01; HC also available in English and French from ONERA, Paris FF 70

Correlations obtained by ONERA researchers in studies of large amplitude oscillations in airfoils are discussed. The correlation values were generated with a dynamic model for helicopter rotor blades experiencing nonlinear oscillations in the lift/angle of attack or moment/angle of attack hysteresis loops. Comparisons were made between the model predictions and data from NASA experiments with NACA 0012 airfoils at varying angles of attack, amplitudes and frequencies. The model proved adequate for predicting the hysteresis loops and in identifying stall behavior. M.S.K. (IAA)

N86-27223# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).

HELICOPTER NOISE

R. LEGENDRE *In its* La Recherche Aerospatiale. Bimonthly Bulletin, no. 1984-6, November - December 1984 (ESA-TT-907) 3 p May 1985 Previously announced in IAA as A86-12025
Avail: NTIS HC A04/MF A01; HC also available in English and French from ONERA, Paris FF 70

The state of the art in predicting and modeling helicopter noise, its sources, components, magnitudes and dynamic characteristics, is assessed. Noise is not emitted by steady flow, and can be decomposed into noise and pseudo-noise. Account must be taken of pseudo-noise in considerations of passenger comfort. The evolution of vortices in the turbulent boundary layer, the turbulent wake and at the blade tips produces noise. The difficulty in predicting noise arises from the complex behavior of vortices, atmospheric processes which affect the noise during flight and interactions among noise effects of separate blades and the fuselage noise. Various experiments are suggested for deriving quantitative laws to improve noise prediction efforts. M.S.K. (IAA)

N86-27224# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Fluid Dynamics and Flight Mechanics Panel.

UNSTEADY AERODYNAMICS-FUNDAMENTALS AND APPLICATIONS TO AIRCRAFT DYNAMICS

Loughton, England Nov. 1985 620 p In ENGLISH and FRENCH Symposium held in Goettingen, West Germany, 6-9 May 1985
(AGARD-CP-386; ISBN-92-835-0382-1) Avail: NTIS HC A99/MF A01

Recent advances in the methods for experimentation and computational prediction of nonlinear flow phenomena in unsteady aerodynamics and of stability parameters required to describe adequately the dynamic behavior of aircraft with special emphasis on high angle-of-attack were examined. Topics addressed include: unsteady boundary layers; unsteady separation and stall; buffeting; unsteady airloads; wind tunnel and flight test techniques, with emphasis on the measurement of nonlinearities, aerodynamic cross-coupling, hysteresis, and time dependent effects; mathematical modeling; bifurcation theory; prediction of wing rock; and advanced control systems.

N86-27226# United Technologies Research Center, East Hartford, Conn.

DYNAMIC STALL OF SWEPT AND UNSWEPT OSCILLATING WINGS

F. O. CARTA *In* AGARD Unsteady Aerodynamics-Fundamentals and Applications to Aircraft Dynamics 15 p Nov. 1985
Avail: NTIS HC A99/MF A01

Recent unsteady tests on oscillating tunnel-spanning wings (representative of full scale helicopter blades) have shown that the dynamic stall phenomena for a swept wing model is significantly different from that for an unswept wing. Several critical measurements and calculations relative to the behavior of the surface flow were made, including chordwise wave speed of the stalling vortex, the degree of pitch rate dependence of the vortex inception angle, and the ability of the cosine law for sweep to normalize unsteady poststall behavior, even after reattachment occurs. Finally, an examination of hot-film response data shows that the stagnation flow along the swept wing leading edge significantly alters the unsteady surface flow behavior in a narrow region along the leading edge when compared with data from the unswept wing. However, from approximately 15 percent chord and aft there appears to be no sweep effect, and the results from both wings are nearly indistinguishable. Author

N86-27228# Vrije Universiteit, Brussels (Belgium). Dept. of Fluid Mechanics.

VELOCITY AND TURBULENCE MEASUREMENTS IN DYNAMICALLY STALLED BOUNDARY LAYERS ON AN OSCILLATING AIRFOIL

J. DERUYCK and C. HIRSCH *In* AGARD Unsteady Aerodynamics-Fundamentals and Applications to Aircraft Dynamics 13 p Nov. 1985 Sponsored in part by Belgian National Research Funds (NFWO)
(Contract DAJA45-83-C-0021)
Avail: NTIS HC A99/MF A01

Detailed velocity and turbulence properties in the dynamically stalled boundary layer of an oscillating NACA 0012 airfoil were measured. The airfoil oscillated around an axis at 25% distance from the leading edge with a sinusoidal motion. Measurements are performed at eight chordwise positions, in non-stalled, stall onset, and deep stalled flow conditions. Instantaneous detailed flow and turbulence patterns of the periodic separation vortex are presented and discussed. Corresponding terms of the turbulent energy balance are derived and compared with flat plate boundary layer data. In particular, negative turbulent energy production is observed during vortex development. Author

N86-27229# Centre National de la Recherche Scientifique, Marseilles (France). Inst. de Mecanique des Fluides.

WING PROFILE IN STALLED POSITION SUBJECT TO A FLOW OF ALTERNATING POTENTIAL AND STRONG VORTEX [PROFIL D'AILE EN DECROCHAGE SOUMIS A UN ECOULEMENT ALTERNATIVEMENT POTENTIEL ET A FORT VORTICITE]

C. MARESCA and D. FAVIER *In* AGARD Unsteady Aerodynamics-Fundamentals and Applications to Aircraft Dynamics 15 p Nov. 1985 In FRENCH
Avail: NTIS HC A99/MF A01

The aerodynamic behavior of a wing profile subject to a flow of alternating potential and strong vortex is examined. The simulation experiment consisted of placing a fixed wing profile in the wake of a profile that oscillated at stalling incidence parallel to the flow. The results show that the effects on the fixed profile may be theoretically approximated by considering the profile as isolated in the flow while the amplitude of the speed and the incidence are simultaneously variable with the pre-established values. Transl. by T. R.

N86-27230# Lockheed Missiles and Space Co., Sunnyvale, Calif.

A CRITICAL LOOK AT DYNAMIC SIMULATION OF VISCOUS FLOW

L. E. ERICSSON *In* AGARD Unsteady Aerodynamics-Fundamentals and Applications to Aircraft Dynamics
11 p Nov. 1985
Avail: NTIS HC A99/MF A01

A critical examination is made of the classic role of the wind tunnel as a tool for simulation of the free flight aerodynamics. That the equivalence concept established for steady flow is not valid for unsteady flow is no great surprise. More surprising, probably, is the fact that simulation of the relative velocity time history, which assures simulation of the inviscid unsteady aerodynamics, will in many cases not assure simulation of the unsteady viscous flow. In the case of flow separation and associated hysteresis the lack of simulation of the transient viscous flow can sometimes even generate the incorrect final steady state flow condition. Only close attention to the simulation of the unsteady boundary condition at the vehicle surface can assure the utility of experimental and numerical results for prediction of full scale unsteady viscous flow characteristics. Author

N86-27231# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen (West Germany). Inst. fuer Aeroelastik.
UNSTEADY BOUNDARY-LAYER SEPARATION ON AIRFOILS PERFORMING LARGE-AMPLITUDE OSCILLATIONS: DYNAMIC STALL
W. GEISSLER *In* AGARD Unsteady Aerodynamics-Fundamentals and Applications to Aircraft Dynamics 12 p Nov. 1985
Avail: NTIS HC A99/MF A01

Experimental investigations have exposed a strong dependency of unsteady separation characteristics in the regime of dynamic stall on airfoil shape, Reynolds and Mach number, and frequency and time dependence incidence. A suitable prediction method should be able to account for these various parameters. Coupling procedures between two-dimensional unsteady boundary layers and inviscid surface singularity methods (panel methods) were developed for analytical investigation of unsteady turbulent separation. The influence of various parameters on unsteady separation is discussed in detail and comparison with experimental data is made. The results show that, even for weak coupling between boundary layer and inviscid boundary condition, good correspondence exists between theory and experiment with respect to the development of unsteady separation. Author

N86-27232*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
COMPUTATIONAL ASPECTS OF UNSTEADY FLOWS
T. CEBECI (Douglas Aircraft Co., Inc., Long Beach, Calif.), L. W. CARR, A. A. KHATTAB, and S. M. SCHIMKE *In* AGARD Unsteady Aerodynamics-Fundamentals and Applications to Aircraft Dynamics 25 p Nov. 1985
(Contract F496720-82-C-0055)
Avail: NTIS HC A99/MF A01 CSCL 01A

The calculation of unsteady flows and the development of numerical methods for solving unsteady boundary layer equations and their application to the flows around important configurations such as oscillating airfoils are presented. A brief review of recent work is provided with emphasis on the need for numerical methods which can overcome possible problems associated with flow reversal and separation. The zig-zag and characteristic box schemes are described in this context, and when embodied in a method which permits interaction between solutions of inviscid and viscous equations, the characteristic box scheme is shown to avoid the singularity associated with boundary layer equations and prescribed pressure gradient. Calculations were performed for a cylinder started impulsively from rest and oscillating airfoils. The results are presented and discussed. It is conlcuded that turbulence models based on an algebraic specification of eddy viscosity can be adequate, that location of translation is important to the calculation of the location of flow separation and, therefore, to the overall lift of an oscillating airfoil. Author

N86-27236# Mykytow (Walter J.), Weymouth, Mass.
REVIEW OF SMP 1984 SYMPOSIUM ON TRANSONIC UNSTEADY AERODYNAMICS AND ITS AEROELASTIC APPLICATIONS
W. J. MYKYTOW *In* AGARD Unsteady Aerodynamics-Fundamentals and Applications to Aircraft Dynamics
45 p Nov. 1985
Avail: NTIS HC A99/MF A01

The latest methods of predicting transonic unsteady airloads for oscillating surfaces and flutter were discussed. Also considered were aerolelastic applications, many of which were made to standard AGARD configurations. The 16 papers and the round table discussion were summarized for coordination with the Fluid Dynamics Panel and the Fluid Mechanics Panel. B.G.

N86-27237*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
TRANSONIC AERODYNAMIC AND AEROELASTIC CHARACTERISTICS OF A VARIABLE SWEEP WING
P. M. GOORJIAN, G. P. GURUSWAMY (Informatics, Inc., Palo Alto, Calif.), H. IDE (Rockwell International Corp., Los Angeles, Calif.), and G. MILLER *In* AGARD Unsteady Aerodynamics-Fundamentals and Applications to Aircraft Dynamics 15 p Nov. 1985 Previously announced as N85-25203
Avail: NTIS HC A99/MF A01 CSCL 01A

The flow over the B-1 wing is studied computationally, including the aeroelastic response of the wing. Computed results are compared with results from wind tunnel and flight tests for both low-sweep and high-sweep cases, at 25.0 and 67.5 deg., respectively, for selected transonic Mach numbers. The aerodynamic and aeroelastic computations are made by using the transonic unsteady code ATRAN3S. Steady aerodynamic computations compare well with wind tunnel results for the 25.0 deg sweep case and also for small angles of attack at the 67.5 deg sweep case. The aeroelastic response results show that the wing is stable at the low sweep angle for the calculation at the Mach number at which there is a shock wave. In the higher sweep case, for the higher angle of attack at which oscillations were observed in the flight and wind tunnel tests, the calculations do not show any shock waves. Their absence lends support to the hypothesis that the observed oscillations are due to the presence of leading edge separation vortices and are not due to shock wave motion as was previously proposed. Author

N86-27238# National Aerospace Lab., Amsterdam (Netherlands).
UNSTEADY AIRLOAD COMPUTATIONS FOR AIRFOIL OSCILLATING IN ATTACHED AND SEPARATED COMPRESSIBLE FLOW
R. HOUWINK *In* AGARD Unsteady Aerodynamics-Fundamentals and Applications to Aircraft Dynamics 8 p Nov. 1985
Avail: NTIS HC A99/MF A01

Recent developments in coupled inviscid flow-boundary layer computations are discussed for airfoils in unsteady motion in attached and separated subsonic and transonic flow. The applicability of quasi-simultaneous strong interaction coupling procedures for transonic small perturbation theory and boundary layer integral methods is illustrated for oscillating airfoils with shock-induced separation. The relevance of the predicted airloads for aeroelastic applications is illustrated using the analysis of an aeroelastic instability of a supercritical wing wind tunnel model. Author

N86-27239# Dornier-Werke G.m.b.H., Friedrichshafen (West Germany).
WIND TUNNEL AND FLIGHT TEST ANALYSIS AND EVALUATION OF THE BUFFET PHENOMENA FOR THE ALPHA JET TRANSONIC WING
H. BUERS and V. SCHMITT (Office National d'Etudes et de Recherches Aeronautiques, Paris, France) *In* AGARD Unsteady Aerodynamics-Fundamentals and Application to Aircraft Dynamics 11 p Nov. 1985
Avail: NTIS HC A99/MF A01

In addition to previous presentations of wind tunnel and flight test data of the Dornier Transsonischer Tragfluegel (TST) program, results of local flow surveys on the wing in the buffeting region are presented. The vibration levels on the wing and at the pilot's seat are also shown. The separated effects of the slats in use both with and without trailing edge flaps as maneuver flaps up to the transonic flight regime are presented. Author

N86-27240# Max-Planck-Institut fuer Stroemungsforschung, Goettingen (West Germany).
UNSTEADY VORTEX AIRFOIL INTERACTION
G. E. A. MEIER and R. TIMM *In* AGARD Unsteady Aerodynamics-Fundamentals and Applications to Aircraft Dynamics 10 p Nov. 1985
Avail: NTIS HC A99/MF A01

The unsteady flow in the vicinity of an airfoil in a subsonic flow with strong vortices is investigated for a two-dimensional problem. Emphasis was placed on the interaction of the passing vortex flow field with the steady flow field of the airfoil. Unsteady flow separation and generation of new vortices of the airfoil occurs depending on vortex strength and core path. Inviscid calculations of vortex paths and sound generation are compared with the experimental results. The associated pressure waves have a strong directivity. The vortices used for the interaction experiments are generated by different vortex shedding cylinders in a stationary duct flow or by airfoils in the starting flow of a shock-tube. High speed interferometric flow recording and wall pressure measurement are the main experimental techniques. Author

N86-27241# Westland Helicopters Ltd., Yeovil (England).
UNSTEADY AERODYNAMICS APPLICATION TO HELICOPTER NOISE AND VIBRATION SOURCES
T. S. BEDDOES *In* AGARD Unsteady Aerodynamics-Fundamentals and Applications to Aircraft Dynamics
10 p Nov. 1985
Avail: NTIS HC A99/MF A01

The feasibility of producing aerodynamic loads of sufficient fidelity to enable a realistic acoustic signal to be derived was studied. The need arises from the excessive blade/slap noise which results from blade/vortex interaction. A tool is required to investigate the influence of design and operational parameters as a routine procedure. For this purpose a simplified two dimensional model was developed and validated against a more sophisticated analysis. The model is extended to the rotor application where the complex wake geometry is the determining factor in the character of the loading. From the distributed transient loading an acoustic signal was derived which was compared with experimental data. A comprehensive correlation was not yet performed but the preliminary results are encouraging. Author

N86-27242*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
RECENT DEVELOPMENTS IN ROTARY-BALANCE TESTING OF FIGHTER AIRCRAFT CONFIGURATIONS AT NASA AMES RESEARCH CENTER
G. N. MALCOLM and L. B. SCHIFF *In* AGARD Unsteady Aerodynamics-Fundamentals and Applications to Aircraft Dynamics 25 p Nov. 1985 Previously announced as N85-32090
Avail: NTIS HC A99/MF A01 CSCL 01A

Two rotary balance apparatuses were developed for testing airplane models in a coning motion. A large scale apparatus, developed for use in the 12-foot Pressure Wind Tunnel primarily to permit testing at high Reynolds numbers, was recently used to investigate the aerodynamics of 0.05-scale model of the F-15 fighter aircraft. Effects of Reynolds number, spin rate parameter, model attitude, presence of a nose boom, and model/sting mounting angle were investigated. A smaller apparatus, which investigates the aerodynamics of bodies of revolution in a coning motion, was used in the 6-by-6 foot Supersonic Wind Tunnel to investigate the aerodynamic behavior of a simple representation of a modern fighter, the Standard Dynamic Model (SDM). Effects of spin rate parameter and model attitude were investigated. A description of the two rigs and a discussion of some of the results obtained in the respective tests are presented. Author

N86-27243# Royal Aircraft Establishment, Bedford (England). Aerodynamics Dept.
NEW ROTARY RIG AT RAE AND EXPERIMENTS ON HIRM
C. O. OLEARY and E. N. ROWTHORN *In* AGARD Unsteady Aerodynamics-Fundamentals and Applications to Aircraft Dynamics 14 p Nov. 1985
Avail: NTIS HC A99/MF A01

A rig for measurement of forces and moments due to continuous rate of roll was commissioned at Royal Aircraft Establishment, Bedford. Tests were made on a High Incidence Research Model (HIRM) in two wind tunnels at $M = 0.2$, 0.4, and 0.7. At present models can be tested up to 40 deg angle of attack at rotational speeds up to 350 rpm. Tests on HIRM included an investigation of configuration and Reynolds number effects. Results are compared with similar data from tests with another rolling rig and from small amplitude oscillatory tests. Author

N86-27244# Aeronautical Research Inst. of Sweden, Bromma.
NEW DYNAMIC TESTING TECHNIQUES AND RELATED RESULTS AT FFA
T. JANSSON and L. TORNGREN *In* AGARD Unsteady Aerodynamics-Fundamentals and Applications to Aircraft Dynamics 14 p Nov. 1985
Avail: NTIS HC A99/MF A01

Extraction of dynamic derivatives from wind tunnel testing was emphasized in recent years. This is shown from the number of different rigs developed and in use, both in the subsonic and transonic wind tunnels. Brief descriptions of the different rigs, testing procedures and data handling were given. A wide survey of the different rigs used for dynamic derivative testing and the corresponding testing capability are presented. B.G.

N86-27245# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen (West Germany). Inst. fuer Aeroelastik.
STANDARD DYNAMICS MODEL EXPERIMENTS WITH THE DFVLR/AVA TRANSONIC DERIVATIVE BALANCE
E. SCHMIDT *In* AGARD Unsteady Aerodynamics-Fundamentals and Applications to Aircraft Dynamics 16 p Nov. 1985
Avail: NTIS HC A99/MF A01

A slender high-load forced-oscillation measuring system for dynamic derivatives of aircraft and missile models in a transonic wind tunnel is presented together with typical test results of the significant aerodynamic coefficients and stability derivatives of the Standard Dynamics Model, a simplified fighter aircraft model with a wing span of 0.345 m. The measurements in the rotational modes pitch, yaw, and roll encompass Mach numbers from 0.6 to 1.2, angles of attack from 0 to 30 degrees, and excitation frequencies from 2 to 20 Hz at a constant Reynolds number of 7.8 Mio/m. Most of the stiffness and damping derivatives gathered show substantial nonlinear dependence on Mach number and angle of attack, whereas the influence of reduced frequency is less prominent. The results are closely related to published measurements on Standard Dynamic Models performed in other NATO countries. Author

N86-27246# Institut de Mecanique des Fluides de Lille (France).
RECENT DEVELOPMENTS IN TECHNIQUES FOR DYNAMIC SIMULATION FOR THE IDENTIFICATION OF STABILITY PARAMETERS [RECENTS DEVELOPPEMENTS DES TECHNIQUES DE SIMULATION DYNAMIQUE APPLIQUEES A L'IDENTIFICATION DES PARAMETRES DE STABILITE]
D. TRISTRANT and O. RENIER *In* AGARD Unsteady Aerodynamics-Fundamentals and Applications to Aircraft Dynamics 14 p Nov. 1985 In FRENCH
Avail: NTIS HC A99/MF A01

In the aircraft dynamic behavior prediction context, experimental methods and analytical procedures which allow mathematical linear modeling parameters to be identified, using a test apparatus located at the Institut de Mecanique des Fluides de Lille is presented. The rig characteristics, the experimental procedures, the identification methods, and results from different aircraft models

will be described. Emphasis is put on the interest of a specific lambda degree of freedom angle formed by the rotational vector and velocity vector. Effectively, it is shown that rotational tests with a non zero value of lambda offer interesting possibilities for identification and allow the estimation of linear model parameters in the case of a quasi-linear path. A different degree of freedom, called gyration radius, was obtained by fixing a special mechanism onto the test apparatus. By carrying out a carefully selected test program, this degree of freedom allows the whole set of stability parameters to be identified, given the structure of the linear mathematical model. Finally, dynamic measures obtained during oscillatory coning using a complete aircraft model produced in evidence the large amplitude of unsteady aerodynamic phenomena at high angles of attack, which could not be ignored if prediction of post stall evolutions is sought. Author

N86-27247# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). , Inst. fuer Flugmechanik.
GENERATION OF TWO-DIMENSIONAL GUST FIELDS IN SUBSONIC WIND-TUNNELS
B. KRAG and W. WEGNER (Technische Univ., Brunswick, West Germany) *In* AGARD Unsteady Aerodynamics-Fundamentals and Applications to Aircraft Dynamics 12 p Nov. 1985
Avail: NTIS HC A99/MF A01

For a variety of flight vehicles, problems during flight in turbulence at subsonic speeds are expected: mainly slow flying helicopters, tilt rotorcraft, aircraft maneuvering at high angles of attack, wing in ground effect vehicles, and aircraft with active controlled wings. The investigation of these problems posses large difficulties. The analyst rapidly enters domains where computational methods fail and where wind tunnel experiments are necessary. This raises the problem of stimulating atmospheric turbulence in a wind tunnel. Until now, no fundamental investigations of the problem of gust generation in wind tunnels were undertaken. Investigations of gust generations were started in a model subsonic wind tunnel. In order to recognize the influence of the main parameters, like number of lift generating wings, chord length, trailing edge-flap or jet-flap, constant chord wing or side-wall mounted winglets, four different types of gust generators were investigated. The gust field was harmonically oscillating. Frequency response measurements of the gust angle of attack were made, covering the complete volume of the test section. Additionally the flow field in the wind tunnel behind harmonically oscillating gust generator flaps was calculated. The results were compared with the measurements. Author

N86-27248*# National Aeronautics and Space Administration. Dryden (Hugh L.) Flight Research Center, Edwards, Calif.
EXTRACTION OF AERODYNAMIC PARAMETERS FOR AIRCRAFT AT EXTREME FLIGHT CONDITIONS
K. W. ILIFF *In* AGARD Unsteady Aerodynamics-Fundamentals and Applications to Aircraft Dynamics 21 p Nov. 1985
Avail: NTIS HC A99/MF A01 CSCL 01A

The maximum likelihood estimator was used to extract stability and control derivatives from flight data for many years. Most of the literature on aircraft estimation concentrates on new development and applications, assuming familiarity with basic concepts. The maximum likelihood estimator and the aircraft equations of motion that the estimator uses are discussed. The current strength and limitations associated with obtaining flight-determined aerodynamic coefficients in extreme flight conditions are assessed. The importance of the careful combining of wind tunnel results (or calculations) and flight results and the thorough evaluation of the mathematical model is emphasized. The basic concepts of minimization and estimation are examined for a simple computed aircraft example, and the cost functions that are to be minimized during estimation are defined and discussed. Graphic representations of the cost functions are given to help illustrate the minimization process. Finally, the basic concepts are generalized, and estimation of stability and control derivatives from flight data is discussed. Author

N86-27249*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
NONLINEAR PROBLEMS IN FLIGHT DYNAMICS INVOLVING AERODYNAMIC BIFURCATIONS
M. TOBAK and G. T. CHAPMAN *In* AGARD Unsteady Aerodynamics-Fundamentals and Applications to Aircraft Dynamics 15 p Nov. 1985 Previously announced as N85-25206
Avail: NTIS HC A99/MF A01 CSCL 01A

Aerodynamic bifurcation is defined as the replacement of an unstable equilibrium flow by a new stable equilibrium flow at a critical value of a parameter. A mathematical model of the aerodynamic contribution to the aircraft's equations of motion is amended to accommodate aerodynamic bifurcations. Important bifurcations such as, the onset of large-scale vortex shedding are defined. The amended mathematical model is capable of incorporating various forms of aerodynamic responses, including those associated with dynamic stall of airfoils. E.A.K.

N86-27250*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
BIFURCATION THEORY APPLIED TO AIRCRAFT MOTIONS
W. H. HUI (Waterloo Univ., Ontario) and M. TOBAK *In* AGARD Unsteady Aerodynamics-Fundamentals and Applications to Aircraft Dynamics 14 p Nov. 1985 Previously announced as N85-23705
Avail: NTIS HC A99/MF A01 CSCL 01A

The bifurcation theory is used to analyze the nonlinear dynamic stability characteristics of single-degree-of-freedom motions of an aircraft or a flap about a trim position. The bifurcation theory analysis reveals that when the bifurcation parameter, e.g., the angle of attack, is increased beyond a critical value at which the aerodynamic damping vanishes, a new solution representing finite-amplitude periodic motion bifurcates from the previously stable steady motion. The sign of a simple criterion, cast in terms of aerodynamic properties, determines whether the bifurcating solution is stable (supercritical) or unstable (critical). For the pitching motion of a flap-plate airfoil flying at supersonic/hypersonic speed, and for oscillation of a flap at transonic speed, the bifurcation is subcritical, implying either that exchanges of stability between steady and periodic motion are accompanied by hysteresis phenomena, or that potentially large aperiodic departures from steady motion may develop. On the other hand, for the rolling oscillation of a slender delta wing in subsonic flight (wing rock), the bifurcation is found to be supercritical. This and the predicted amplitude of the bifurcation periodic motion are in good agreement with the experiments. Author

N86-27251# National Research Council of Canada, Ottawa (Ontario).
DYNAMIC NONLINEAR AIRLOADS: REPRESENTATION AND MEASUREMENT
E. S. HANFF *In* AGARD Unsteady Aerodynamics-Fundamentals and Applications to Aircraft Dynamics 14 p Nov. 1985
Avail: NTIS HC A99/MF A01

A new representation of aerodynamic reactions (in terms of the motion variables), which does not rely on assumptions of linearity, is proposed. This representation is, therefore, indicated for extreme flight conditions where a locally linearized model is usually of questionable value. The significance within the present context of stability derivatives is discussed with the intention of pointing out their range of applicability. A wind tunnel technique, capable of efficiently obtaining the bulk of the data required for the effective use of the representation is briefly described. Author

N86-27252*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
RECENT EXPERIENCES OF UNSTEADY AERODYNAMIC EFFECTS ON AIRCRAFT FLIGHT DYNAMICS AT HIGH ANGLE OF ATTACK
L. T. NGUYEN, R. D. WHIPPLE, and J. M. BRANDON *In* AGARD Unsteady Aerodynamics-Fundamentals and Applications to Aircraft Dynamics 25 p Nov. 1985
Avail: NTIS HC A99/MF A01

Recent research is highlighted which was conducted at the NASA Langley Research Center on two high angle-of-attack flight dynamic phenomena which are dominated by unsteady aerodynamic effects: wing rock and tumbling. Studies of wing rock induced by strong vortical flows and tumbling characteristics observed on an advanced configuration are reviewed. Results of wind tunnel experiments are summarized and the aerodynamic mechanisms involved in the phenomena were discussed. Author

N86-27253# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio. Avionics Lab.
UNSTEADY AERODYNAMICS AND DYNAMIC AIRCRAFT MANEUVERABILITY
J. D. LANG and M. S. FRANCIS (Air Force Space Div., Los Angeles, Calif.) *In* AGARD Unsteady Aerodynamics-Fundamentals and Applications to Aircraft Dynamics 19 p Nov. 1985
Avail: NTIS HC A99/MF A01

A forecast of future aerial combat predicated on anticipated technological advances and weapons developments suggests a need for supermaneuverable aircraft possessing greatly enhanced turning and virtually instantaneous point-and-shoot capabilities. The potential advantage of exploiting this unique flight environment was discussed along with a detailed description of expected vehicle dynamic behavior. An emerging picture of the unsteady aerodynamic behavior which will be experienced during these violent maneuvers dictates a need for greater vehicle and flow field control capabilities far in excess of any previously employed in application. However, the successful implementation of advanced control techniques may well beneficially exploit the unusual flow phenomena associated with this nonclassical method of flight. The research discoveries and developmental ideas generated during the next decade will likely alter the concept of maneuvering flight as it is known and lead to a new generation of aircraft with vastly improved combat capabilities. Author

N86-27254# London Univ. (England). Dept. of Aeronautical Engineering.
ON THE INTERFACE BETWEEN UNSTEADY AERODYNAMICS, DYNAMICS AND CONTROL
G. J. HANCOCK and R. VEPA *In* AGARD Unsteady Aerodynamics-Fundamentals and Applications to Aircraft Dynamics 12 p Nov. 1985
Avail: NTIS HC A99/MF A01

The problems of interfacing the mathematical representation of linearized unsteady aerodynamics with dynamic response such that the eigenvalue of the dynamic response are correctly obtained. These eigenvalues are then used in control synthesis. Particular attention is paid to C sub M2 (lag effect between the main wing and tail) in the context of aircraft dynamics. The concept of quasi-steady aerodynamics is clarified. Author

N86-27255# Royal Aircraft Establishment, Farnborough (England).
CORRELATION OF PREDICTED AND FREE-FLIGHT RESPONSES NEAR DEPARTURE CONDITIONS OF A HIGH INCIDENCE RESEARCH MODEL
A. J. ROSS and G. F. EDWARDS *In* AGARD Unsteady Aerodynamics-Fundamentals and Applications to Aircraft Dynamics 13 p Nov. 1985
Avail: NTIS HC A99/MF A01

The mathematical model of aerodynamic forces and moments is described, based on results from various wind tunnel experiments with the Royal Airforce Establishment High Incidence Research Model (HIRM). Simulations of the responses due to longitudinal and lateral control inputs at high angles of attack are compared with the responses measured on free-flight models of the configuration. The main features of the flight behavior are reproduced, in particular such phenomena as roll-off, wing rock, and nose slice. Author

N86-27256# Kansas Univ., Lawrence. Dept. of Aerospace Engineering.
THEORETICAL PREDICTION OF WING ROCKING
C. E. LAN *In* AGARD Unsteady Aerodynamics-Fundamentals and Applications to Aircraft Dynamics 13 p Nov. 1985
Avail: NTIS HC A99/MF A01

Wing rock is primarily a rolling oscillation about the longitudinal body axis at high angles of attack. It involves nonlinear interaction between flight dynamics and aerodynamics. A nonlinear aerodynamic model was proposed earlier to predict the wing rock frequency and amplitude of low aspect-ratio configurations with good accuracy. The theory is applied to a twin-jet fighter aircraft of moderate aspect ratio and to a low-speed configuration of high aspect ratio. For the purpose of predicting necessary aerodynamic derivatives, a lifting surface method coupled with nonlinear airfoil section data is developed. The results show that wing rock can be predicted with the present wing-rock and aerodynamic theories. It is also found that for configurations of high aspect ratio, the one degree of freedom dynamic model in the present wing rock theory should be used. For other configurations, the three degrees of freedom model is more appropriate. Author

N86-27257# Technische Hogeschool, Delft (Netherlands). Dept. of Aerospace Engineering.
EFFECTS OF AERODYNAMIC LAGS ON AIRCRAFT RESPONSES
J. C. VANDERVAART *IN* AGARD **Unsteady Aerodynamics-Fundamentals and Applications to Aircraft Dynamics**
11 p Nov. 1985
Avail: NTIS HC A99/MF A01

Results of a theoretical study on the effects of unsteady aerodynamics on symmetric aircraft responses due to elevator and vertical turbulence imputs, are presented. Several linear models were developed to describe unsteady lift and downwash and delays due to horizontal tail length. Results for three example aircraft types show that calculated normal acceleration levels due to turbulence are very little affected by including unsteady wing lift and downwash. However, there appears to be a noticeable influence on plunging acceleration and pitch rate response to elevator or vertical turbulence inputs. Author

N86-27258# Smith Associates Consulting System Engineers Ltd., Cobham (England).
A SELF-ORGANISING CONTROL SYSTEM FOR NON-LINEAR AIRCRAFT DYNAMICS
C. EVANS *In* AGARD Unsteady Aerodynamics-Fundamentals and Applications to Aircraft Dynamics 12 p Nov. 1985
Avail: NTIS HC A99/MF A01

At high angles of attack (AOA) flow separations can produce nonlinear and time varying aerodynamic loads, which cannot be predicted with great certainty. Such loads make control system development extremely difficult. A control system was developed which can accomplish on-line reduction of the a priori uncertainties pertaining to the effective control of the aircraft. The self-organizing control system was developed to suppress unacceptable pitch-up tendencies of an aircraft at high AOA, without the use of AOA measurement. The final control system demonstrated good performance for a variety of inputs although performance was not as good in turbulence. Author

N86-27259# Messerschmitt-Boelkow G.m.b.H., Munich (West Germany). Hubschrauber und Flugzeuge.
GUST ALLEVIATION ON A TRANSPORT AIRPLANE
J. BECKER, F. WEISS, E. CAVATORTA (Aeritalia S.p.A., Naples, Italy), and C. CALDARELLI *In* AGARD Unsteady Aerodynamics-Fundamentals and Applications to Aircraft Dynamics 9 p Nov. 1985
Avail: NTIS HC A99/MF A01

A Gust Alleviation System on a preliminary configuration of a commuter aircraft was analyzed. The analysis takes into account the influence of the elasticity of the aircraft, unsteady aerodynamic effect, and mechanical nonlinearities such as backlash-deadzone, control surface rate, and deflection limitations. A relatively simple model shows that ride comfort can be improved by at least 50%. Author

N86-27261*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
UNSTEADY INTERACTIONS OF TRANSONIC AIRFOILS WITH GUSTS AND CONCENTRATED VORTICES
W. J. MCCROSKEY and G. R. SRINIVASAN (JAI Associates, Mountain View, Calif.) *In* AGARD Unsteady Aerodynamics-Fundamentals and Applications to Aircraft Dynamics 13 p Nov. 1985
Avail: NTIS HC A99/MF A01

Unsteady interactions of strong concentrated vortices, distributed gusts, and sharp-edged gusts with stationary airfoils were analyzed in two-dimensional transonic flow. A simple and efficient method for introducing such vortical disturbances was implemented in numerical codes that range from inviscid, transonic small-disturbance to thin-layer Navier Stokes. The numerical results demonstrate the large distortions in the overall flow field and in the surface air loads that are produced by various vortical interactions. The results of the different codes are in excellent qualitative agreement, but, as might be expected, the transonic small-disturbance calculations are deficient in the important region near the leading edge. Author

N86-27262# Hellenic Air Force Technology Research Center, Athens (Greece).
MODELLING OF THE VORTEX-AIRFOIL INTERACTION
A. G. PANARAS *In* AGARD Unsteady Aerodynamics-Fundamentals and Applications to Aircraft Dynamics 16 p Nov. 1985
Avail: NTIS HC A99/MF A01

A modeling of the vortex-airfoil interaction is presented in which the finite-area of the real vortices is taken into consideration. Two vortex models are used. In the first, a disturbed piece of vorticity layer is simulated by four rows of discrete vortices of small strength. In the second, a number of discrete vortices is arranged within a circle. The first model may simulate a shear layer or a wake, while the second, a well-formed vortex. The method was applied to the calculation of the pressure induced on the surface of the airfoil by the interacting vortex. Both models give similar results. It was found that for large distances of the vortex from the surface of the airfoil, the consideration or not of the finite-area of the vortex is not a significant factor in determining the induced pressure field. However, when the distance of the vortex from the surface is reduced, its shape is distorted and the induced pressure pulses have lower amplitude than the ones induced by an equivalent point vortex. In the limit, where the vortex impinges on the leading edge of the airfoil, it is split into two and the time dependent pressure coefficient takes even negative values at some time intervals. Author

N86-27263# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Inst. fuer Flugmechanik.
IDENTIFICATION OF AIRCRAFT CHARACTERISTICS INCLUDING GUST INDUCED DYNAMIC EFFECTS
D. ROHLF *In* AGARD Unsteady Aerodynamics-Fundamentals and Applications to Aircraft Dynamics 8 p Nov. 1985
Avail: NTIS HC A99/MF A01

For the investigation of unsteady aerodynamic effects at low Mach numbers, dynamic tests using controllable models of a light transport aircraft were performed in wind tunnels in the Dynamic Simulation Facility (Germany) and the Free Flight Catapult Facility (France). These model test techniques have the advantage of laboratory conditions with the possibility of generating reproducible qusts. The achieved flight test data were analyzed in detail applying method of system identification. This included the determination of the discrete gust disturbance from onboard measured signals. An approach was presented which used the measured angle of attack and additional calculated dynamic terms, which become essential in the presence of fast flow changes due to short-wave gusts or high-frequency control deflection. Measured time histories of model flight tests with excitation by control inputs and gusts are presented and compared with identification results obtained from the multi-run evaluation. Author

N86-27264# Sherbrooke Univ. (Quebec). Dept. de Genie Mecanique.
EXPERIMENTAL STUDY OF THE EFFECT OF TURBULENCE ON DYNAMIC STALLING [ETUDE EXPERIMENTALE DE L'EFFET DE LA TURBULENCE SUR LE DECROCHAGE DYNAMIQUE]
A. LANEVILLE, P. VITTECOQ, and J. COTE *In* AGARD Unsteady Aerodynamics-Fundamentals and Applications to Aircraft Dynamics 7 p Nov. 1985 In FRENCH
Avail: NTIS HC A99/MF A01

The results of a study of dynamic stalling for different intensities of turbulence in the flow of a wind tunnel are presented. The test was conducted on a NACA 0018 profile with sinusoidal oscillation. The results show that turbulence modifies both static and dynamic stall phenomena. It is shown that turbulence stabilizes the boundary layer at the leading edge, while allowing the profile to attain larger angles of incidence before stalling. In addition, turbulence alters the formation of vortices at the leading edge. Transl. by T. R.

N86-27265*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
APPLICATION OF CFD TECHNIQUES TOWARD THE VALIDATION OF NONLINEAR AERODYNAMIC MODELS
L. B. SCHIFF and J. KATZ *In* AGARD Unsteady Aerodynamics-Fundamentals and Applications to Aircraft Dynamics 15 p Nov. 1985 Previously announced as N85-26671
Avail: NTIS HC A99/MF A01 CSCL 14B

Applications of computational fluid dynamics (CFD) methods to determine the regimes of applicability of nonlinear models describing the unsteady aerodynamic responses to aircraft flight motions are described. The potential advantages of computational methods over experimental methods are discussed and the concepts underlying mathematical modeling are reviewed. The economic and conceptual advantages of the modeling procedure over coupled, simultaneous solutions of the gas dynamic equations and the vehicle's kinematic equations of motion are discussed. The modeling approach, when valid, eliminates the need for costly repetitive computation of flow field solutions. For the test cases considered, the aerodynamic modeling approach is shown to be valid. Author

N86-27266# Office National d'Etudes et de Recherches Aeronautiques, Paris (France).
STUDY OF THE TRANSITION BEHAVIOR OF AN AIRPLANE IN THE VICINITY OF BIFURCATION POINTS [ETUDE DU COMPORTEMENT TRANSITOIRE D'UN AVION AU VOISINAGE DE POINTS DE BIFURCATION]
P. GUICHETEAU *In* AGARD Unsteady Aerodynamics-Fundamentals and Applications to Aircraft Dynamics
7 p Nov. 1985 In FRENCH
Avail: NTIS HC A99/MF A01

The transition behavior of an aircraft in the vicinity of bifurcation points, using a differential system method to analytically determine nonlinearities is discussed. The method proposed does not require the reduction of the differential system. Primary applications for this method include studies on fighter aircraft. Transl. by T. R.

03

AIR TRANSPORTATION AND SAFETY

Includes passenger and cargo air transport operations; and aircraft accidents.

A86-37327
THE RISK TO THIRD PARTY PERSONNEL FROM RPV OPERATIONS
V. COHEN (Theta Analysis and Systems, Ltd., Aldershot, England) IN: Remotely piloted vehicles; International Conference, 5th, Bristol, England, September 9-11, 1985, Proceedings . Bristol, England, University of Bristol, 1985, p. 3.1-3.7.

An evaluation is made of the risk that RPV battlefield operations present for ground personnel. Statistical material has been drawn from accident records for manned aircraft in the UK representing 11,600 accidents of relevant type, including 55 cases of third-party injury. Attention was given to possible correlations between injury rate and such variables as the aircraft wingspan and the weight/speed of aircraft. Considerable expense is projected for an RPV system complying with the required reliability levels. O.C.

A86-37469
AN AVIATION COMPOSITE HAZARDS PRODUCT
W. D. ZITTEL (NOAA, National Weather Service, Norman, OK) IN: International Conference on the Aviation Weather System, 2nd, Montreal, Canada, June 19-21, 1985, Preprints . Boston, MA, American Meteorological Society, 1985, p. 109-116. refs

The progress made by the Interim Operational Test Facility Staff between April and July 1984 in the founding of an aviation composite hazards product for the Next Generation Weather Radar (NEXRAD) is summarized. In designing this product, such hazards as heavy rain, gust fronts, turbulence, wind shear and tornadoes were considered injurious to aviation. Line contours were established for each hazard which were subsequently described functionally. The identity of each hazard was maintained and the contours were sufficiently grated to maintain time and space continuity. Hazards having areal extent were functionally described using harmonic analysis. Areas discussed in detail include NEXRAD algorithms, the mathematical methodology, display construction and future work. The results attest to the feasibility of functionally contouring hazards for use in an aviation composite hazards product. K.K.

A86-37477
THE HAZARDS OF ASH CLOUDS TO CIVIL AIR TRANSPORT
MR. REDDAN (Air France, Roissy, France) IN: International Conference on the Aviation Weather System, 2nd, Montreal, Canada, June 19-21, 1985, Preprints . Boston, MA, American Meteorological Society, 1985, p. 146, 147.

The hazard posed to commercial aviation by ash clouds from erupting volcanoes is discussed. The capability of cloud matter to cause engine failure, to erode windshields, leading edges, fan blades, aerials, and landing lights, and to choke filters and pipes is described. Radar and satellite methods of detecting ash clouds are addressed, and the importance of further measures is stressed, particularly the need for a network to gather and distribute information. C.D.

A86-37478
METEOSAT-DERIVED QUANTITATIVE MEASUREMENTS ON VOLCANIC ASH PLUMES FOR WARNING TO AVIATION
B. BIZZARRI, P. PAGANO, and M. PERRONE (Aeronautica Militare Italiana, Servizio Meteorologico, Rome, Italy) IN: International Conference on the Aviation Weather System, 2nd, Montreal, Canada, June 19-21, 1985, Preprints . Boston, MA, American Meteorological Society, 1985, p. 148-151. refs

The use of the Meteosat satellite to detect and evaluate plumes of volcanic ash which pose a danger to aviation is discussed. A Meteosat infrared image of a plume is shown and discussed, and the image is used to derive quantitative information on the plume's height, emissivity, optical thickness, eruption energy, ash mass, mass evolution and abatement, and vertical distribution and concentration. The verification of these analytical results and the evaluation of the risk posed by this plume are briefly discussed. A possible procedure for warning aircraft is considered. C.D.

A86-37479* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
NASA STORM HAZARDS RESEARCH IN LIGHTNING STRIKES TO AIRCRAFT
B. D. FISHER, P. W. BROWN (NASA, Langley Research Center, Hampton, VA), and J. A. PLUMER (Lightning Technologies, Inc., Pittsfield, MA) IN: International Conference on the Aviation Weather System, 2nd, Montreal, Canada, June 19-21, 1985, Preprints . Boston, MA, American Meteorological Society, 1985, p. 152-160. refs

The lightning strike condition data gathered in the 1980-1984 period are presented, together with the lightning attachment point analysis for the NASA F-106B research aircraft are presented. The analysis of the experienced 637 direct lightning strikes shows that the highest strike rates (2.1 strikes/min and 13 strikes/penetration) occurred at altitudes between 38,000 and 40,000 ft. The regions of highest risk for an aircraft to experience a direct lightning strike were the areas of thunderstorms where the ambient temperature was colder than -40 C and where the relative turbulence and precipitation intensities were characterized as negligible to light. The presence and location of lightning, therefore, did not necessarily indicate the presence and location of hazardous precipitation and turbulence. The total onboard data show that the lightning attachment patterns on this aircraft fall into four general categories, although the 1984 data suggest that the entire surface of the F-106B may be susceptible to lightning attachment. I.S.

A86-37482
TERRAIN-INDUCED WIND SHEAR - POTENTIAL CAUSE OF JETSTAR ACCIDENT
W. FROST (Tennessee, University, Tullahoma), J. MCCARTHY, P. HILDEBRAND (National Center for Atmospheric Research, Boulder, CO), and K. H. HUANG (FWG Associates, Inc., Tullahoma, TN) IN: International Conference on the Aviation Weather System, 2nd, Montreal, Canada, June 19-21, 1985, Preprints . Boston, MA, American Meteorological Society, 1985, p. 177-185. Research supported by the U.S. Department of Justice and NSF. refs

An investigation was made to ascertain the effects of terrain-induced wind shear on the Jetstar accident near Westchester County Airport, in White Plains, New York on February 11, 1981. A mathematical model of the quasi-steady winds experienced by the airplane was developed, with computer-simulated turbulence fluctuations superimposed. The approach path of the aircraft through these winds was computed using a six-degree-of-freedom, aircraft dynamics computer program. These models were collaborated by simulating the flow field in an atmospheric boundary layer simulation water tunnel. The

mathematical model of the wind field exhibited excellent agreement with these water tunnel simulations, and it is concluded that the model presented is a realistic simulation of the wind shear effects that may have influenced the accident. Moreover, the results illustrate that terrain features along airport approach paths can produce augmented low-level turbulence together with hazardous wind shear. K. K.

A86-37489

THE CRASH OF C-GTLA - THE CUMULATIVE EFFECTS OF SMALL DEFECTS AND A HINT OF A PREVIOUSLY UNRECOGNIZED MAJOR METEOROLOGICAL HAZARD

W. F. ZELTMANN (International Weather Corp., Brooklyn, NY) IN: International Conference on the Aviation Weather System, 2nd, Montreal, Canada, June 19-21, 1985, Preprints . Boston, MA, American Meteorological Society, 1985, p. 218, 219.

The November 1983 crash of the C-CGTLA aircraft in the vicinity of the Lansdowne House weather station in Northern Ontario is investigated. A severe winter storm was centered over Wisconsin and moving northward; heavy snow was falling in the vicinity of Lansdowne House on a steady flow of northeasterly winds off Hudson Bay and James Bay. The whiteout conditions experienced by the pilot may have been enhanced by a microburst within instability snow showers. It is noted that a combination of a microburst and a whiteout is extremely hazardous, and a serious effort must be made to determine how often these two phenomena occur together. It is suggested that past accident reports by canvassed to determine their mutual frequency, and that an airport on the shores of the Great Lakes be instrumented to obtain statistical data. K.K.

A86-37490

LIGHTNING MEASUREMENTS OF AN AIRCRAFT FLYING AT LOW ALTITUDE

P. L. RUSTAN, JR. and J. L. HEBERT (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) IN: International Conference on the Aviation Weather System, 2nd, Montreal, Canada, June 19-21, 1985, Preprints . Boston, MA, American Meteorological Society, 1985, p. 220-225. refs

In a combined USAF/FAA inflight lightning-measurements program, an instrumented FAA CV-580 aircraft flew in and near active thunderstorms in Florida; data were collected on 21 direct lightning strikes to the aircraft. The primary purpose of this program was to characterize the lightning waveform so that the electromagnetic hazards to aircraft due to lightning strikes could be determined. Meteorological conditions conducive to lightning strikes were investigated, and these CV-580 statistics were compared to those obtained by other research aircraft as well as commercial and military aircraft. The CV-580 experienced 63 percent of its strikes at an altitude of 18,000 ft, at which point the aircraft was closer to the large negative charge center of the thunderstorm and more likely to trigger an intracloud discharge. The characteristics of this discharge are also a function of altitude. K.K.

A86-37625

MICROCOMPUTERS AND AVIATION

P. GARRISON New York, Wiley Press, 1985, 279 p.

The different ways in which microcomputers can be useful to pilots and others involved in different phases of aviation are discussed. The Flight Simulator II software aviation package, which turns a microcomputer into a fully-equipped stationary single-engine aircraft which can take off, fly, and land is examined. A variety of commercially marketed software packages that can be used by pilots for flight planning and instrument training are described. A library of aviation programs is presented which can be keyed into a microcomputer to perform a variety of tasks, such as determining weight-and-balance conditions, finding takeoff distances under different wind, weather, and runway conditions and the determining the best cruising altitude based on winds aloft. C.D.

A86-37940

PUTTING A PRICE ON SAFETY

R. ASHFORD (Civil Aviation Authority, London, England) Flight International (ISSN 0015-3710), vol. 129, April 19, 1986, p. 39-42.

The differences between the US Federal Airworthiness Regulations (FAR 25) and the European Joint Airworthiness Requirements (JAR 25) are elucidated, and the demands by aircraft manufacturing and operating industries for greater uniformity of international standards are investigated. It is proposed that the aviation industry should insist on both the deletion of these differences, and their resolution. Moreover, no regulation should be allowed where the savings do not exceed the cost; in US safety terms, savings are expressed in terms of lives saved (valued at $650,000 per life in 1983) and the material losses avoided. Examples are provided of aircraft components which have taken these factors into account. The value of airworthiness directives is demonstrated in light of the British Airtours Boeing 737 accident in August, 1985, and it is recommended that authorities be totally independent of their country's manufacturers, operators and accident investigators. It is concluded that air safety regulation is essential; without it, the airlines would be in an even more competitive position. K.K.

A86-38343

HUMAN INJURY CRITERIA RELATIVE TO CIVIL AIRCRAFT SEAT AND RESTRAINT SYSTEMS

R. F. CHANDLER (FAA, Civil Aeromedical Institute, Oklahoma City, OK) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 12 p. refs
(SAE PAPER 851847)

The use of injury criteria as a basis for the acceptance of seats and restraint systems designed to possess some capacity for crash injury protection has been common for several years in military aircraft and automotive systems, but has only recently been considered for civil aircraft systems. This paper will present the background for the concept of 'injury criteria' as distinct from 'voluntary human tolerance', and will explain methods used in developing certain criteria which are most likely to be useful in evaluating civil aircraft seat and restraint system performance. Finally, techniques for using the measurements in testing will be summarized, and guidance will be provided to the system designer which may assist in meeting the goals established by the criteria. Author

A86-38344

UPPER TORSO RESTRAINT SYSTEMS

E. L. JAERGER (Cessna Aircraft Co., Wichita, KS), H. W. SMITH (Kansas, University, Livermore), and R. F. CHANDLER (FAA, Protection and Survival Laboratory, Oklahoma City, OK) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 8 p.
(SAE PAPER 851848)

A new SAE Aerospace Standard has been developed for upper torso restraint systems in anticipation of mandatory installation in 1986. Shoulder harness integration with pelvic restraint belts are described. Load and performance tests of complete assemblies are described. Details of the system include webbing, seat anchors, buckles, buckle mating plates, adjusters, and emergency locking retractors. Minimum performance requirements and tests for each component are prescribed in the new standard. Tests include effect of flame, light solvents, and abrasion of the webbing. The hardware must qualify for corrosion, temperature and durability. Entire assemblies must be tested to prescribed pelvic and harness loads. These tests are described. Author

A86-38351

CONTROLLED IMPACT DEMONSTRATION REVIEW

N. A. BLAKE (FAA, Washington, DC) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 6 p.
(SAE PAPER 851884)

Data from the controlled impact demonstration conducted on December 1, 1984 by the FAA and NASA are analyzed. The

effectiveness of the antimisting fuel additives, seats and restraint systems, and the cabin fire safety materials was evaluated and crashworthiness/crash behavior data was collected. The proposed and actual aircraft impact profiles are described. The test data reveal that the cabin conditions remained habitable, all emergency exits were operable, and the seat fire blocking layers and restraint systems were effective; however, it is observed that under certain conditions the antimisting fuel is not sufficient to prevent a post-crash fire. The crashworthiness data are applied to computer modeling programs for predicting impact forces and crash behavior, and to crash dynamics structural research. I.F.

A86-38352* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

NASA EXPERIMENTS ONBOARD THE CONTROLLED IMPACT DEMONSTRATION

R. J. HAYDUK, E. ALFARO-BOU (NASA, Langley Research Center, Hampton, VA), and E. L. FASANELLA (PRC Kentron, Inc., Hampton, VA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 13 p.
(SAE PAPER 851885)

The structural crashworthiness tests conducted by NASA on the December 1, 1984 controlled impact demonstration are discussed. The components and locations of the data acquisition and photographic systems developed by NASA to evaluate impact loads throughout the aircraft structure and the transmission of loads into the dummies are described. The effectiveness of the NASA designed absorbing seats and the vertical, longitudinal, and transverse impact loads are measured. Data that is extremely applicable to crash dynamics structural research was obtained by the data acquisition system and very low load levels were measured for the NASA energy absorbing seats. I.F.

A86-38353

ANTIMISTING FUEL TECHNOLOGY FOR TRANSPORT CATEGORY AIRCRAFT

E. P. KLUEG (FAA, Washington, DC) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 17 p. refs
(SAE PAPER 851886)

The Federal Aviation Administration has been engaged in research and development efforts aimed at reducing the fire hazard during impact-survivable aircraft crashes by modifying kerosene jet fuels. Primary emphasis has been placed on utilizing high molecular weight, polymeric additives to produce antimisting kerosene fuels which are compatible with commercial transport aircraft and engine fuel systems and are more resistant to vaporization, ignition, and flame propagation in the crash situation. The program background is reviewed, and recently-completed research and development efforts are discussed. Topics covered include the rheological, physical, and flammability properties; the airport production techniques; and aircraft fuel system compatibility characteristics of antimisting kerosene fuel. The results of the full-scale validation phase of the program are also discussed, including aircraft ground and flight tests and a full-scale transport aircraft impact demonstration. Author

A86-38354

FAA STRUCTURAL CRASH DYNAMICS PROGRAM UPDATE - TRANSPORT CATEGORY AIRCRAFT

S. SOLTIS, C. CAIAFA (FAA, Washington, DC), and G. WITTLIN (Lockheed-California Co., Burbank, CA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 19 p. refs
(SAE PAPER 851887)

The objectives and initial findings of the FAA-sponsored structural crash dynamics research are described. Results from the fuselage drop tests, full scale aircraft drop tests, and the Controlled Impact Demonstration are presented. A computer modeling program for improved transport aircraft crash dynamics, correlated with the test data, is being developed. A seat/occupant model representative of transport category aircraft seats has been developed. I.S.

A86-38381

THE F-16 AIRCRAFT AND HYDRAZINE - AN INDUSTRIAL HYGIENE PERSPECTIVE

W. D. CHRISTENSEN (USAF, Occupational and Environmental Health Laboratory, Brooks AFB, TX) and J. A. MARTONE (USAF, Harry G. Armstrong Aerospace Medical Research Laboratory, Wright-Patterson AFB, OH) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 7 p. refs
(SAE PAPER 851971)

The USAF program for controlling potential exposure to hydrazine during maintenance of the F-16 aircraft is discussed. The effects of exposure to hydrazine on the skin, eyes, air passages, lungs, the central nervous system, and the liver are described. A maximum eight hour time weighted average airborne concentration of hydrazine to which personnel may be exposed is 0.10 ppm oor 0.13 mg/cu m; procedures for evaluating exposure to hydrazine during aircraft maintenance activities are analyzed. The development of a closed system for maintenance of the F-16 emergency power unit is examined. I.F.

A86-38382

DESIGN, SAFETY, AND MAINTAINABILITY ASPECTS FOR HYDRAZINE USE IN EMERGENCY SECONDARY POWER SYSTEMS

E. V. SCICCHITANO and E. J. BUNDAS (Grumman Aerospace Corp., Bethpage, NY) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 10 p.
(SAE PAPER 851972)

Emergency power system evaluation will be briefly considered since the approach selected is dependent upon aircraft mission. A rationale for the selection of hydrazine as a primary system, or in conjunction with other systems, has been developed. This paper will address the influence of safety and maintainability considerations upon hydrazine systems design. Concerns in these areas have limited the widespread use of hydrazine in aircraft secondary power systems. To dispel these concerns, extensive experience accumulated to date with hydrazine is examined and applied to operational considerations to provide increased confidence required in considering hydrazine as a viable candidate energy source for aircraft secondary power systems. Author

A86-38511

DATA FOR THE DEVELOPMENT OF CRITERIA FOR GENERAL AVIATION SEAT AND RESTRAINT SYSTEM PERFORMANCE

R. F. CHANDLER (FAA, Civil Aeromedical Institute, Oklahoma City, OK) IN: Crash dynamics of general aviation aircraft; Proceedings of the General Aviation Aircraft Meeting and Exposition, Wichita, KS, April 16-19, 1985 . Warrendale, PA, Society of Automotive Engineers, Inc., 1985, p. 13-28. refs
(SAE PAPER 850851)

The recommendations of the General Aviation Safety Panel (GASP) for improving crash injury protection in small aircraft are described. A two test procedure for seat and restraint systems was developed. The first test involves forward and downward loading on a seat using a 170 lb dummy and providing an impact velocity of 31 ft/s with a duration of 0.1 s and the second procedure is a forward impact test with an impact velocity of 42 ft/s acting 10 deg to one side of the seat for a 0.1 s duration. The test facility and equipment employed to evaluate the test procedures are examined. The combined vertical and forward test data on seat pan fabrics and adhesive bonds, the elasticity of the adjustment mechanism, armrests, pelvic and shoulder belt load limitations, and head impact are analyzed. The tests revealed that the procedures recommended by GASP provide appropriate performance goals for the seat and restraint systems of small aircraft. I.F.

A86-39553

LOW ALTITUDE WIND-SHEAR PROTECTION CAN BE ATTAINED

L. M. GREEN (Safe Flight Instrument Corp., White Plains, NY) ICAO Bulletin, vol. 41, April 1986, p. 10-13.

The development of reliable, highly redundant, and self-contained airborne wind shear warning (WSW) recovery guidance (RG) system designed to complement the ground-based systems to effectively protect against sudden and severe wind shear encounters is described. The WSW system, which includes a radio altimeter, continuously computes the aircraft performance loss due to the combined horizontal and vertical forces of wind shear, and gives audiovisual warnings as the aircraft starts to enter a shear, in time for performance (in nine or more seconds) of a successful recovery maneuver. The RG system then continuously computes attitude guidance for recovery displayed on the pitch command bars of the flight director, requiring the pilot only to follow the command bars to produce the best possible climb profile. Simulator results are discussed. I.S.

N86-26295# Princeton Univ., N. J. Dept. of Mechanical and Aerospace Engineering.

A DEMONSTRATION EXPERT SYSTEM FOR IMPLEMENTING EMERGENCY PROCEDURES IN A HIGH-PERFORMANCE FIGHTER AIRCRAFT

B. L. BELKIN Apr. 1986 14 p refs

(MAE-1749) Avail: NTIS HC A02/MF A01

A demonstration expert system was developed using a knowledge acquisition tool to simulate the operation of an electronic pilot's assistant operating on-board a high-performance fighter aircraft. The task selected for this simulation was the implementation of in-flight emergency procedures for the canopy loss scenario described in the F-16 Flight Manual. Four modes of pilot assistance operation were identified. Two modes require the Electronic Pilot's Assistant to help the pilot with routine flight tasks. The other two modes require the Electronic Pilot's Assistant to autonomously plan and execute procedures to maintain control of the aircraft in the event the pilot is incapacitated or subject to unmanageable workload. Author

N86-26296*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

LIGHTNING DISCHARGE PROTECTION ROD Patent Application

C. F. BRYAN, JR., inventor (to NASA) 24 Apr. 1986 14 p Sponsored by NASA

(NASA-CASE-LAR-13470-1; NAS 1.71:LAR-13470-1; US-PATENT-APPL-SN-855983) Avail: NTIS HC A02/MF A01 CSCL 01C

This invention is a system for protecting an in-air vehicle from damage due to the craft sustaining a lightning strike. It is an extremely simple device consisting of a sacrificial graphite composite rod, approximately the diameter of a pencil with a length of about five inches. The sacrificial rod is constructed with the graphite fibers running axially within the rod in a manner that best provides a path of conduction axially from the trailing edge of an aircraft to the trailing end of the rod. The sacrificial rod is inserted into an attachment hole 32 machined into trailing edges of aircraft flight surfaces, such as vertical fin cap 31, and attached with adhesive in a manner not prohibiting the conduction path between the rod and aircraft. The trailing end of rod may be tapered for aerodynamic and esthetic requirements. This rod is sacrificial but has the capability to sustain several lightning strikes and still provide protection. The novelty of this invention appears to reside in a system for protecting the most vulnerable parts of an in-air vehicle when the craft is hit by lightning with an extremely simple and inexpensive device. The materials are easily procured and the sacrificial rod generally can be constructed from the same composite as the flight or control surface to be protected. The protection extends to several in-air lightning strikes and provides protection to aircraft parts manufactured from all materials including organic composites. NASA

N86-26298# Simula, Inc., Phoenix, Ariz.

CRASH-RESISTANT CREWSEAT LIMIT-LOAD OPTIMIZATION THROUGH DYNAMIC TESTING WITH CADAVERS Final Report, May 1979 - Dec. 1985

J. W. COLTMAN, C. V. INGEN, and F. SELKER Jan. 1986 112 p

(Contract DAAK51-79-C-0016; DA PROJ. 1L1-62209-AH-76) (AD-A164828; TR-85422; USAAVSCOM-TR-85-D-11) Avail: NTIS HC A06/MF A01 CSCL 01B

The threshold of spinal injury for seated humans subjected to +Gz loading was investigated. The +Gz loading was induced by simulating crash conditions typically found in helicopter crashes, and modified by the use of energy-absorbing mechanisms incorporated in the seat structure. Fifteen tests were conducted with unembalmed cadavers as human surrogates at various limit-load settings to attempt to identify the load threshold causing spinal injury. Bone strength analysis was used to normalize the results of the cadaver test program. Performance data and autopsy results for the 15 crash tests are presented. A correlation was derived relating the frequency of spinal injury to the energy absorber limit-load factor for use in design of crashworthy seating systems. Comparison of the incidence of spinal injury between the experimental test data developed through testing with cadavers and field performance of production energy-absorbing seats is discussed. The report also contains a discussion of the biomechanics of trauma associated with the human spine, including mechanical properties of the spine, typical injury mechanisms for +Gz loading, and theoretical models for predicting injury. GRA

N86-26299# Coordinating Research Council, Inc., Atlanta, Ga.

FLAMMABILITY OF AIRCRAFT HYDRAULIC FLUIDS: A BIBLIOGRAPHY

Jan. 1986 46 p refs

(Contract DAAK70-86-C-0011)

(AD-A165463; CRC-546) Avail: NTIS HC A03/MF A01 CSCL 11H

As part of an overall effort to collect flammability data on aircraft fluids, a critical survey was made of the aircraft hydraulic oil literature, with particular emphasis on flammability testing and flammability characteristics of existing and projected aircraft hydraulic fluids. Commercial aviation and military aviation fluids are treated separately, in view of their divergent development. Flammability test procedures are described. Flammability test results and other inspection tests are given for a variety of current and proposed aircraft hydraulic fluids. GRA

N86-26301# National Transportation Safety Board, Washington, D. C. Bureau of Safety Programs.

TRANSPORTATION SAFETY RECOMMENDATIONS ADOPTED DURING THE MONTH OF DECEMBER 1985

1986 95 p

(PB85-916612; NTSB-REC-85-12) Avail: NTIS MF A01; also available on subscription, North American Continent price HC $65.00/year; all others write for quote CSCL 01B

The publication contains safety recommendations in aviation, highway and marine modes of transportation adopted by the National Transportation Safety Board during the month of December, 1985. GRA

N86-26302# National Transportation Safety Board, Washington, D. C. Bureau of Technology.

SAFETY REPORT GENERAL AVIATION CRASHWORTHINESS PROJECT. PHASE 3: ACCELERATION LOADS AND VELOCITY CHANGES OF SURVIVABLE GENERAL AVIATION ACCIDENTS Report, 1972 - 1981

4 Sep. 1985 187 p

(PB85-917016; NTSB-SR-85-02) Avail: NTIS MF A01; also available on subscription, North American Continent price HC $60.00/year; all others write for quote CSCL 01C

The report is the last in a series of three reports issued by the National Transportation Safety Board as a result of its General Aviation Crashworthiness Program. The purpose of the program is to provide information to support changes in crashworthiness

design standards for seating and restraint systems in general aviation airplanes. A Phase One report presents a methodology for documenting impact severity. A Phase Two report presents specific data on survivable accidents which demonstrate that if all occupants wear shoulder harnesses, fatalities are expected to be reduced by 20 percent. Eighty-eight percent of the seriously injured persons in survivable crashes are expected to experience significantly fewer life-threatening injuries. The Phase Three report provides analytical results of actual crashes. The values of acceleration loads and velocity changes that occupants can sustain in survivable, modern aviation airplane accidents are defined. GRA

N86-26303# National Transportation Safety Board, Washington, D. C. Bureau of Field Operations.
AIRCRAFT ACCIDENT REPORTS, BRIEF FORMAT, US CIVIL AND FOREIGN AVIATION ISSUE NUMBER 3 OF 1984 ACCIDENTS
18 Oct. 1985 421 p
(PB85-916922) Avail: NTIS HC A18/MF A01; paper copy also avail. on subscription, North American Continent price $185.00/year; all others write for quote CSCL 01B

Selected aircraft accident reports in brief format occurring in the U.S. civil and foreign aviation operations during calender year 1984 are presented. Approximately 200 general aviation and air carrier accidents contained in the publication represent a random selection. The publication is issued irregularly, normally eighteen times each year. The brief format represent the facts, conditions, circumstances, and probable causes for each accident. GRA

N86-26304# National Transportation Safety Board, Washington, D. C. Bureau of Field Operations.
AIRCRAFT ACCIDENT REPORTS, BRIEF FORMAT, US CIVIL AND FOREIGN AVIATION ISSUE NUMBER 4 OF 1984 ACCIDENTS
14 Nov. 1985 416 p
(PB85-916923; NTSB-AAB-85-23) Avail: NTIS HC A18/MF A01; paper copy also available on subscription, North American Continent price $185.00/year; all others write for quote CSCL 01B

This fourth issue contains selected aircraft accident reports in brief format occurring in U.S. civil and foreign aviation operations during calender year 1984. Approximately 200 general aviation and air carrier accidents contained in the publication are selected at random. The publication is issued approximately eighteen times each year at irregular intervals. The brief format contains the facts, conditions, circumstances, and probable cause(s) for each accident. GRA

N86-26305# National Transportation Safety Board, Washington, D. C.
AIRCRAFT ACCIDENT REPORTS, BRIEF FORMAT, US CIVIL AND FOREIGN AVIATION ISSUE NUMBER 5 OF 1984 ACCIDENTS
24 Jan. 1986 418 p
(PB86-916901; NTSB-AAB-86-01) Avail: NTIS HC A03/MF A01; paper copy also avail. on subscription, North American Continent price $185.00/year; all others write for quote CSCL 01B

The publication contains selected aircraft accident reports in Brief Format occurring in U.S. civil and foreign aviation operations during Calendar Year 1984. Approximately 200 General Aviation and Air Carrier accidents contained in the publication represent a random selection. The publication is issued irregularly, normally eighteen times each year. The Brief Format represents the facts, conditions, circumstances and probable causes(s) for each accident. Issue 5 includes file numbers 801 through 1000. GRA

N86-26306# National Transportation Safety Board, Washington, D. C.
AIRCRAFT ACCIDENT REPORTS, BRIEF FORMAT, US CIVIL AND FOREIGN AVIATION ISSUE NUMBER 6 OF 1984 ACCIDENTS
24 Jan. 1986 418 p
(PB86-916902; NTSB-AAB-86-02) Avail: NTIS HC A18/MF A01; paper copy also avail. on subscription, North American Continent price $185.00/year; all others write for quote CSCL 01B

The publication contains selected aircraft accident reports in Brief Format occurring in U.S. civil and foreign aviation operations during Calendar Year 1984. Approximately 200 General Aviation and Air Carrier accidents contained in the publication represent a random selection. The publication is issued irregularly, normally eighteen times each year. The Brief Format represents the facts, conditions, circumstances and probable cause(s) for each accident. Issue 6 includes file numbers 1001 through 1200. GRA

N86-26307# National Transportation Safety Board, Washington, D. C. Bureau of Field Operations.
AIRCRAFT ACCIDENT REPORTS, BRIEF FORMAT, US CIVIL AND FOREIGN AVIATION ISSUE NUMBER 7 OF 1984 ACCIDENTS
22 Nov. 1985 421 p
(PB86-916903; NTSB-AAB-86-03) Avail: NTIS HC A18/MF A01; paper copy also avail. on subscription, North America Continent price $185.00/year; all others write for quote CSCL 01B

The publication contains selected aircraft accident reports in Brief Format occurring in U.S. civil and foreign aviation operations during Calendar Year 1984. Approximately 200 General Aviation and Air Carrier accidents contained in the publication represent a random selection. The publication is issued irregularly, normally eighteen times each year. The Brief Format represents the facts, conditions, circumstances and probable cause(s) for each accident. Issue 7 includes file numbers 1201 through 1400. GRA

N86-26308# National Transportation Safety Board, Washington, D. C. Bureau of Field Operations.
AIRCRAFT ACCIDENT REPORTS, BRIEF FORMAT, US CIVIL AND FOREIGN AVIATION ISSUE NUMBER 8 OF 1984 ACCIDENTS
22 Nov. 1985 421 p
(PB86-916904; NTSB-AAB-86-04) Avail: NTIS HC A18/MF A01; paper copy also avail. on subscription, North American Continent price $185.00/year; all others write for quote CSCL 01B

The publication contains selected aircraft accident reports in Brief Format occurring in U.S. civil and foreign aviation operations during Calendar Year 1984. Approximately 200 General Aviation and Air Carrier accidents contained in the publication represent a random selection. The publication is issued irregularly, normally eighteen times each year. The Brief Format represents the facts, conditions, circumstances and probable cause(s) for each accident. Issue 8 includes file numbers 1401 through 1600. GRA

N86-26309# National Transportation Safety Board, Washington, D. C. Bureau of Field Operations.
AIRCRAFT ACCIDENT REPORTS, BRIEF FORMAT, US CIVIL AND FOREIGN AVIATION ISSUE NUMBER 9 OF 1984 ACCIDENTS
29 Nov. 1985 400 p
(PB86-916905; NTSB-AAB-86-05) Avail: NTIS HC A17/MF A01; paper copy also avail. on subscription, North American Continent price $185.00/year; all others write for quote CSCL 01B

The publication contains selected aircraft accident reports in brief format occurring in U.S. civil and foreign aviation operations during calendar year 1984. Approximately 200 general aviation and air carrier accidents contained in the publication represent a random selection. The publication is issued irregularly, normally eighteen times each year. The brief format represents the facts, conditions, circumstances and probable cause(s) for each accident. Issue 9 includes file numbers 1601 through 1800. GRA

N86-26310# National Transportation Safety Board, Washington, D. C. Bureau of Field Operations.
AIRCRAFT ACCIDENT REPORTS, BRIEF FORMAT, US CIVIL AND FOREIGN AVIATION ISSUE NUMBER 11 OF 1984 ACCIDENTS
16 Dec. 1985 418 p
(PB86-916907; NTSB-AAB-86-07) Avail: NTIS HC A18/MF A01; also avail. on subscription, North American Continent price $185.00/year; all others write for quote CSCL 01B

The publication contains selected aircraft accident reports in Brief Format occurring in U.S. civil and foreign aviation operations during Calendar Year 1984. Approximately 200 General Aviation and Air Carrier accidents contained in the publication represent a random selection. The publication is issued irregularly, normally eighteen times a year. The Brief Format represents the facts, conditions, circumstances and probable cause(s) for each accident. Issue 11 includes file numbers 2001 through 2200. GRA

N86-26311# National Transportation Safety Board, Washington, D. C. Bureau of Field Operations.
AIRCRAFT ACCIDENT REPORTS, BRIEF FORMAT, US CIVIL AND FOREIGN AVIATION ISSUE NUMBER 13 OF 1984 ACCIDENTS
30 Dec. 1985 412 p
(PB86-916909; NTSB-AAB-86-09) Avail: NTIS HC A18/MF A01; also avail. on subscription, North American Continent price $185.00/year; all others write for quote CSCL 01B

The publication contains selected aircraft accident reports in Brief Format occurring in U.S. civil and foreign aviation operations during Calendar Year 1984. Approximately 200 General Aviation and Air Carrier accidents contained in the publication represent a random selection. The publication is issued irregularly, normally eighteen times each year. The Brief Format represents the facts, conditions, circumstances and probable cause(s) for each accident. Issue 13 includes file numbers 2401 through 2600. GRA

N86-27267# National Transportation Safety Board, Washington, D. C.
NATIONAL TRANSPORTATION SAFETY BOARD SAFETY RECOMMENDATION
4 Mar. 1986 6 p
(NTSB-4102C/300A) Avail: NTIS HC A02/MF A01

Vibrations caused by open air start access doors on Lockheed Electras were discussed. Proposed safety measures include: issuance of an Airworthiness Directive to all Electra operators to modify the air start access door; until modification of the door occurs, Principle Operations Inspectors should inform the operators of the potential hazards; establish procedures to ensure adequate surveillance is maintained; verification that supplemental operators are fulfilling their responsibility to see that competent personnel are available to maintain and service the aircraft; evaluate information needed by the crash/fire rescue agencies; and provide guidance on topics and training in cockpit resource management to flightcrew members. B.G.

N86-27268*# Wichita State Univ., Kans. Coll. of Engineering.
ANALYSES AND TESTS FOR DESIGN OF AN ELECTRO-IMPULSE DE-ICING SYSTEM Interim Report
G. W. ZUMWALT, R. L. SCHRAG, W. D. BERNHART, and R. A. FRIEDBERG May 1985 198 p
(Contract NAG3-284)
(NASA-CR-174919; AR-85-1; NAS 1.26:174919) Avail: NTIS HC A09/MF A01 CSCL 01C

De-icing of aircraft by using the electro-magnetic impulse phenomenon was proposed and demonstrated in several European countries. However, it is not available as a developed system due to lack of research on the basic physical mechanisms and necessary design parameters. The de-icing is accomplished by rapidly discharging high voltage capacitors into a wire coil rigidly supported just inside the aircraft skin. Induced eddy currents in the skin create a repulsive force resulting in a hammer-like force which cracks, de-bonds, and expels ice on the skin surface. The promised advantages are very low energy, high reliability of de-icing, and low maintenance. Three years of Electo-Impulse De-icing (EIDI) research is summarized and the analytical studies and results of testing done in the laboratory, in the NASA Icing Research Tunnel, and in flight are presented. If properly designed, EIDI was demonstrated to be an effective and practical ice protection system for small aircraft, turbojet engine inlets, elements of transport aircraft, and shows promise for use on helicopter rotor blades. Included are practical techniques of fabrication of impulse coils and their mountings. The use of EIDI with nonmetallic surface materials is also described. Author

N86-27269# National Transportation Safety Board, Washington, D. C. Bureau of Field Operations.
AIRCRAFT ACCIDENT REPORTS: BRIEF FORMAT, US CIVIL AND FOREIGN AVIATION, ISSUE NUMBER 17 OF 1983 ACCIDENTS
12 Jul. 1985 337 p
(PB85-916918; NTSB/AAB-85/18) Avail: NTIS HC A15/MF A01; also available on subscription, North American Continent HC$185.00/year; all others write for quote CSCL 01B

The publication contains selected aircraft accident reports in Brief Format occurring in U.S. civil and foreign aviation operations during Calendar Year 1983. Approximately 200 General Aviation and Air Carrier accidents contained in the publication represent a random selection. The publication is issued irregularly, normally eighteen times each year. The Brief Format represents the facts, conditions, circumstances and probable cause(s) for each accident. GRA

04

AIRCRAFT COMMUNICATIONS AND NAVIGATION

Includes digital and voice communication with aircraft; air navigation systems (satellite and ground based); and air traffic control.

A86-37334
FLIGHT TEST WITH A TERRAIN AIDED NAVIGATION SYSTEM
E. SKARMAN (Saab Missiles AB, Linkoping, Sweden) IN: Remotely piloted vehicles; International Conference, 5th, Bristol, England, September 9-11, 1985, Proceedings . Bristol, England, University of Bristol, 1985, p. 19.1-19.5. Research supported by the Forsvaret Materielverk.

This article presents flight tests with a terrain-aided inertial navigation system. The system is essentially a nonlinear Kalman filter. The flight tests have been performed in a Sabreliner aircraft, with an altimeter and a strapdown sensor package. The results confirm the simulation model used before, and indicate an 1-sigma error level below 50 m. Author

A86-37336
GROUND CONTROL STATION FOR RPVS
S. JONES (Ferranti Computer Systems, Ltd., Bracknell, England) IN: Remotely piloted vehicles; International Conference, 5th, Bristol, England, September 9-11, 1985, Proceedings . Bristol, England, University of Bristol, 1985, p. 22.1-22.4.

The ground control stations (GCSs) that furnish an interface between RPVs and their tasking agencies may operate autonomously or by way of a coordinating headquarters. Automatic facilities are used for the allocation of tasks to an RPV, for the generation of detailed routing instructions, and for the transmission of these instructions to the RPV. GCS flexibility is obtained through the use of a variety of manual overrides; the GCS also observes sensor imagery, and generates and transmits reports. Attention is given to mission planning and execution, man/machine interfaces, and communications. O.C.

A86-37555
A TECHNIQUE TO EVALUATE THE ACCESSIBILITY OF AIRBORNE RECEIVERS TO INTERFERING SIGNALS
D. P. KOESTER, C. E. COOK, and R. R. STEVENS (Mitre Corp., Bedford, MA) IN: ICC '85; International Conference on Communications, Chicago, IL, June 23-26, 1985, Conference Record. Volume 2 . New York, Institute of Electrical and Electronics Engineers, Inc., 1985, p. 814-821. refs

Techniques to evaluate the accessibility of modern military airborne receivers to tactical jammers are described. Signal detection capabilities of the equipment are analyzed in relation to system performance. Problems encountered in examining adaptive antenna arrays are discussed. The procedures for calculating operability volumes are studied. The effects of radio horizon and terrain on line-of-sight communications are investigated. The contours of maximum communications range are estimated and utilized to evaluate the communications performance for a system configuration and an interference environment. I.F.

A86-38974
EXPERIMENTAL AND THEORETICAL STUDY OF THE EFFECT OF WAVE PROPAGATION ON THE POSTITIONAL ACCURACY OF OMEGA NAVIGATION IN GERMANY [EXPERIMENTELLE UND THEORETISCHE UNTERSUCHUNG UEBER DEN EINFLUSS DER WELLENAUSBREITUNG AUF DIE STANDORTGENAUIGKEIT DER OMEGA-NAVIGATION IN DEUTSCHLAND]
S. BLOCH Braunschweig, Tehnische Universitaet, Fakultaet fuer Maschinenbau und Elektrotechnik, Dr.-Ing. Dissertation, 1984, 290 p. In German. refs

The utilization of the Omega navigational system in southern Germany under given reception and interference conditions is studied. A series of measurements conducted at Stuttgart at various times of day and year is reported. The essential characteristics and variables of VLF propagation are analyzed and discussed, taking into account specific physical relationships which affect the system in Germany. Multifrequency procedures aimed at making the Omega positional determination more independent of ionospheric behavior are discussed. C.D.

A86-39048*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
FUEL CONSERVATIVE GUIDANCE FOR SHIPBOARD LANDING OF POWERED-LIFT STOL AIRCRAFT
D. N. WARNER, JR., L. A. MCGEE (NASA, Ames Research Center, Moffett Field, CA), J. D. MCLEAN, and G. K. SCHMIDT (Analytical Mechanics Associates, Inc., Mountain View, CA) (Guidance, Navigation and Control Conference, Snowmass, CO, August 19-21, 1985, Technical Papers, p. 307-317) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 9, May-June 1986, p. 377-379. Previously cited in issue 22, p. 3225, Accession no. A85-45911.

A86-39535* Ohio State Univ., Columbus.
SIMULATION AND ANALYSIS OF ANTENNAS RADIATING IN A COMPLEX ENVIRONMENT
J. J. KIM (Texas Instruments, Inc., McKinney, TX) and W. D. BURNSIDE (Ohio State University, Columbus) IEEE Transactions on Antennas and Propagation (ISSN 0018-926X), vol. AP-34, April 1986, p. 554-562. refs
(Contract NSG-1498)

A numerical procedure for computing the high-frequency radiation patterns of antennas mounted on curved surfaces is described. The procedure utilizes the uniform geometrical theory of diffraction to examine the antenna system's performance, which is dependent on antenna radiation patterns. Composite ellipsoid models of fuselage shapes are developed and the formation of geodesic paths on the models is studied; the shape of the fuselage affects the radiation patterns. The actual field radiated by the source and scattered by the structure is calculated using the ray field technique. The numerical solution is applied to the analysis of the antenna radiation patterns of a military aircraft, private aircraft, and the Space Shuttle orbiter. Good correlation between the calculated and measured radiation patterns is noted verifying the usefulness and accuracy of the numerical procedure. I.F.

A86-39557
MLS - THE PILOT'S POINT OF VIEW [MLS - LE POINT DE VUE DU PILOTE]
MR. RENOUARD (Union de Transports Aeriens, Puteaux, France) (Seminaire sur le Systeme d'Atterrissage Hyperfrequences 'MLS' Toulouse, France, Nov. 26, 27, 1985) Navigation (Paris) (ISSN 0028-1530), vol. 34, April 1986, p. 145-166. In French.

The benefits and difficulties associated with implementing the Microwave Landing System (MLS) as standard equipment for airline passenger aircraft are considered. MLS offers an elimination of local signal distortions, three-dimensional guidance devoid of local reflectances, and usefulness even when the runway disappears beyond local terrain relief. The precision exceeds that available from current systems during categories I and II landings. Finally, calibration is easier and cheaper. The switchover to MLS from ILS is to be performed over a 12 yr period, implying that the aircraft must carry two different landing guidance systems and pilots must be qualified to operate both of them. The long period of transition would cause a higher fuel consumption rate. It is noted that current display systems do not provide the information in a clear manner, and could be improved by including the MLS in digital display CRT systems, particularly in concert with meteorological displays. Similarly, the MLS and ILS systems could be interoperative and use the same display. Tests are still needed to determine the operability of MLS during category III approaches. Finally, the various on board equipment and procedures associated with implementation of the MLS are discussed. M.S.K.

A86-39558
AIR TRAFFIC CONTROL (ATC) AND VESSEL TRAFFIC SYSTEMS (VTS) [CONTROLE DU TRAFIC AERIEN (ATC) ET SYSTEMES DE TRAFIC DES NAVIRES (VTS)]
MR. GUICHAROUSSE Navigation (Paris) (ISSN 0028-1530), vol. 34, April 1986, p. 167-179. In French.

The requirements of ATC and marine vessel traffic control (VTS) are compared to demonstrate that existing procedures cannot be gainfully transferred between the two. ATC prevents close approaches between aircraft and between aircraft and other obstructions, and facilitates an orderly, optimized flow of air traffic. Clearances are established among aircraft in terms of the time of flight and the lateral and vertical distances between aircraft. The eyes of the pilots are the primary sensors during visual flight rules, i.e., favorable weather, and are augmented by ATC updates, precision radar systems and ILS approach systems during limited visibility conditions. The ATC therefore has an indispensible role, something that is not true for VTS, since marine vessels can stop almost anywhere and can survive unscheduled stops such as groundings. Separation distances between ships are two-dimensional and horizontal. Ships cannot turn around once inside a channel, and their maneuvering stability can be greatly affected simultaneously by wind forces, currents and tidal streams. The amount of time required for a large vessel to stop or turn can be a significant fraction of an hour. Once committed to a channel or port area and having obtained information from the VTS by VHF phone, ship pilots make few demands on the VTS because too much attention is needed for monitoring what can be an extremely varying array of traffic vessels approaching from every direction, with only radar available as a navigational aid. M.S.K.

A86-39561
A MINIMUM ROUTE TIME (MRT) PROGRAM FOR MICROCOMPUTERS [PROGRAMME DE ROUTE A TEMPS MINIMUM (R.T.M.) POUR MICRO-ORDINATEUR]
B. GARCON-DUFOUR (Air France, Direction des Operations Aeriennes, Roissy, France) Navigation (Paris) (ISSN 0028-1530), vol. 34, April 1986, p. 207-212. In French.

A program for minimizing flight distances is presented that requires only kilobytes of RAM and therefore can be run on a microcomputer. Isochronous curves are drawn between two points

and points requiring equal flight times, hour-by-hour, to reach are identified relative to a straight-line distance between airports. The map of shortest-distance points is thereby generated by mapping the shortest routes for an isobaric flight, for the shortest great circle route, and the shortest route with wind perpendicular to the flight path being taken into account. Corrections are introduced for the different altitudes of departure and arrival, for changes in the strength and direction of the wind, and the air temperature along the routes. Geographic coordinates are then interpolated for the identified shortest route. A sample routing plan is worked out for a 200 nm flight. It is noted that accuracy will be enhanced if two sets of computations are carried out using successive weather maps having the same degree of validity. M.S.K.

A86-39562
THE PRESENCE OF THE TRIDENT III ON ANTARCTICA [PRESENCE DU TRIDENT III SUR LE CONTINENT ANTARCTIQUE]
B. DUMAS (Thomson-CSF, Division Avionique Spatiale et Aviation Generale, Issy-les-Moulineaux, France) Navigation (Paris) (ISSN 0028-1530), vol. 34, April 1986, p. 223-237. In French.

The Trident III navigation system was installed at several sites and on several aircraft stationed in Antarctica in support of the GANOVEX IV scientific experiments carried out in 1984-85. The airborne platforms were two Dornier 228 aircraft fitted with magnetometers and the CCNS/Trident equipment for aeromagnetism surveys and precision navigation, respectively. The measurements were carried out over a 240,000 sq km region bounded by Ross and Coulman Islands, the polar plateau and the Ross Sea. Nine solar powered ground beacons were established for the Trident system, and situated in groups by elevation from sea level to 3 km altitude. The ground stations were equipped with either omnidirectional or directional antennas to fit the demands of the flight plans. Two interrogator antennas accessing the ground beacons from the two aircraft were coupled to CCNS data analysis computers, which worked continuously in real time acquiring and recording position data. Occasional failures were encountered among the shoreline beacons due to continuous snow or icing conditions blocking off solar energy for several days at a time. The positioning accuracies obtained using the system are estimated to be within 20-40 m for the 40,000 sq km of coverage accomplished. M.S.K.

A86-39766#
AN TERRAIN-AIDED GUIDANCE SYSTEM WITH HIGH CONVERGENCE SPEED
M. JI (Changsha Institute of Technology, People's Republic of China) Acta Aeronautica et Astronautica Sinica, vol. 7, April 1986, p. 173-180. In Chinese, with abstract in English. refs

A parallel Kalman filter system for terrain-aided guidance, based on the theory of Gaussian Sum in order to meet the requirement of locating flying vehicles with large initial position error, is presented. An order-reduced model is put forth, based on the error analysis of which an adaptive sequential decision (ASD) method is presented. By combining these, the position uncertainty and the amount of calculation can be decreased in steps, and the real-time calculation can be implemented. The performance analysis of ASD gives a practical way to further increase the speed of convergence. It is shown that a fast and accurate location can be provided by the system for a vehicle even with large errors in position, velocity and course. Author

N86-26312*# Princeton Univ., N. J. Dept. of Civil Engineering.
INTEGRATED RISK/COST PLANNING MODELS FOR THE US AIR TRAFFIC SYSTEM
J. M. MULVEY and S. A. ZENIOS Dec. 1985 41 p refs
(Contract NAG1-520; NSF DCR-84-01098)
(NASA-CR-177274; NAS 1.26:177274; EES-85-9) Avail: NTIS HC A03/MF A01 CSCL 17G

A prototype network planning model for the U.S. Air Traffic control system is described. The model encompasses the dual objectives of managing collision risks and transportation costs where traffic flows can be related to these objectives. The underlying structure is a network graph with nonseparable convex costs; the model is solved efficiently by capitalizing on its intrinsic characteristics. Two specialized algorithms for solving the resulting problems are described: (1) truncated Newton, and (2) simplicial decomposition. The feasibility of the approach is demonstrated using data collected from a control center in the Midwest. Computational results with different computer systems are presented, including a vector supercomputer (CRAY-XMP). The risk/cost model has two primary uses: (1) as a strategic planning tool using aggregate flight information, and (2) as an integrated operational system for forecasting congestion and monitoring (controlling) flow throughout the U.S. In the latter case, access to a supercomputer is required due to the model's enormous size. Author

N86-26315# Federal Aviation Agency, Atlantic City, N.J.
MATH MODEL STUDY OF A PROPOSED GLIDE SLOPE FOR RUNWAY 13R, DALLAS-FORT WORTH AIRPORT, TEXAS
J. WALLS Jan. 1986 19 p refs
(AD-A164907; DOT/FAA/CT-TN85/80) Avail: NTIS HC A02/MF A01 CSCL 01E

This document describes instrument landing system (ILS) math modeling performed at the request of the Southwest Region. Data are presented showing the computed performance of a proposed glide slope for runway 13R at the Dallas-Fort Worth Airport, Texas. Model path structure and level run plots are provided for capture effect, null reference, and sideband reference systems installed at a location selected by region engineers. Results indicate that all three systems should meet category II path structure, linearity, and symmetry tolerances. The capture effect system provides the smoothest glidepath structure of the three systems modeled. Author (GRA)

N86-26316# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Guidance and Control Panel.
GUIDANCE-CONTROL-NAVIGATION AUTOMATION FOR NIGHT ALL-WEATHER TACTICAL OPERATIONS
Loughton, England Oct. 1985 136 p refs In ENGLISH and FRENCH The 40th Guidance and Control Panel Symposium was held at The Hague, Netherlands, 21-24 May 1985
(AGARD-CP-387; ISBN-92-835-0381-3) Avail: NTIS HC A07/MF A01

The components, functions, and systems integration required to support the evolution of alternative guidance/control/navigation systems capable of enabling effective and routine night all-weather operations are discussed. Papers are organized under the following headings: operational requirements, systems concepts and integration issues, man-machine interface, terrain reference systems, and mission applications.

N86-26324# Harris Government Aerospace Systems Div., Melbourne, Fla. Digital Cartographic Programs.
APPLICATIONS OF DIGITAL TERRAIN DATA IN FLIGHT OPERATIONS
G. W. CANTRELL *In* AGARD Guidance-Control-Navigation Automation for Night All-Weather Tactical Operations 24 p Oct. 1985
Avail: NTIS HC A07/MF A01

With the availability of a world-wide digital terrain data base becoming a reality, it is now possible to carry and display on a tactical aircraft all of the map information needed for a mission. Along with the map display on a color cathode-ray tube (CRT), current targets and mission-specific data can be shown. The limitations of today's commonly used film readers are eliminated by using a digital data base which contains elevation information; one such data base is the U.S. Defense Mapping Agency's Digital Land Mass System (DLMS). The terrain data can be digitally compressed and efficiently stored so that large area coverages may be achieved. With this information readily available, aircraft mission effectiveness and survivability can be enhanced. The system for accomplishing this task is called a digital map generator (DMG). The DMG architecture encompasses data storage, data

access and reconstruction, data display processing, and data formatting for use by other aircraft subsystems. A DMG architecture was developed for application in low-level or nap-of-the-Earth tactical missions, as well as long range strategic missions. Mission capabilities are enhanced by using this DMG to support terrain following/terrain avoidance (TF/TA), autonomous navigation, threat avoidance, and weapons delivery. In addition, the same digital processing approach is usable for pre-flight mission planning. The ability to plan a flight using the actual mission data base gives the pilot the ability to see exactly where he will be at all times and to determine safe corridors for entry and departure, making maximum use of terrain shielding. Similarly, the terrain data may be used for reference during post-mission debriefing, in which the pilot can refer to in-flight annotations made through the DMG subsystem. Author

N86-26325# Theory and Applications Unlimited Corp., Los Gatos, Calif.

A NEW TECHNIQUE FOR TERRAIN FOLLOWING/TERRAIN AVOIDANCE GUIDANCE COMMAND GENERATION

R. V. DENTON, J. E. JONES, and P. L. FROEBERG *In* AGARD Guidance-Control-Navigation Automation for Night All-Weather Tactical Operations 11 p Oct. 1985 refs

Avail: NTIS HC A07/MF A01

A real-time optimization technique that efficiently generates a robust, optimum terrain following/terrain avoidance (TF/TA) trajectory, and has the structural capability for adding threat avoidance is described. The TF/TA technique presented is based on definition of a performance measure that is systematically optimized in real-time. The approach uses on-board Defense Mapping Agency digital terrain elevation data extensively, as updated by real-time sensor inputs. The optimization of the performance measure embodies the real-time trade-off of flying over (TF) versus flying around terrain features (TA). The performance measure is defined to generally penalize large excursions from the nominal (globally-defined) route, while rewarding a trajectory that achieves better terrain masking than contained in the nominal, mission-planned route. Direct incorporation of limits on the flight control variables (bank angle, roll rate, normal acceleration, etc.) is included within the procedure. The TF/TA technique also addresses additional considerations that apply when combining the TF/TA flight trajectory computation with maneuvers through mission waypoints. This involves several subtleties associated with the relative importance of the turning maneuver desired versus the normally applicable TF/TA performance measure. Finally, the relevance of this work to other advances in trajectory computation is described. This includes the relationship to global trajectory generation, and to integrated TF/TA with threat avoidance TF/(TA)2. Author

N86-26327# Crouzet Aerospace and Systems, Valence (France). Div. Aerospatiale.

A MISSION NAVIGATION AND CONTROL SYSTEM FOR MODERN MILITARY HELICOPTERS [UN SYSTEME DE NAVIGATION ET DE GESTION DE LA MISSION POUR LES HELICOPTERS MILITAIRES MODERNES]

J. L. ROCH *In* AGARD Guidance-Control-Navigation Automation for Night All-Weather Tactical Operations 10 p Oct. 1985 In FRENCH

Avail: NTIS HC A07/MF A01

The requirements of modern military helicopters have fostered the development of navigation systems which use position sensors as a part of a centralized mission control system. An overview of the requirements for modern operational helicopter systems is given, as well as current automatic navigation systems; this is followed by a report of the NADIR MK2 mission navigation and control system developed by the CROUZET Company. Transl. by T.R.

N86-27271*# Princeton Univ., N. J. School of Engineering and Applied Science.

AN OPTIMIZATION MODEL FOR THE US AIR-TRAFFIC SYSTEM Final Report

J. M. MULVEY Apr. 1986 27 p

(Contract NAG1-520)

(NASA-CR-177277; NAS 1.26:177277) Avail: NTIS HC A03/MF A01 CSCL 17G

A systematic approach for monitoring U.S. air traffic was developed in the context of system-wide planning and control. Towards this end, a network optimization model with nonlinear objectives was chosen as the central element in the planning/control system. The network representation was selected because: (1) it provides a comprehensive structure for depicting essential aspects of the air traffic system, (2) it can be solved efficiently for large scale problems, and (3) the design can be easily communicated to non-technical users through computer graphics. Briefly, the network planning models consider the flow of traffic through a graph as the basic structure. Nodes depict locations and time periods for either individual planes or for aggregated groups of airplanes. Arcs define variables as actual airplanes flying through space or as delays across time periods. As such, a special case of the network can be used to model the so called flow control problem. Due to the large number of interacting variables and the difficulty in subdividing the problem into relatively independent subproblems, an integrated model was designed which will depict the entire high level (above 29000 feet) jet route system for the 48 contiguous states in the U.S. As a first step in demonstrating the concept's feasibility a nonlinear risk/cost model was developed for the Indianapolis Airspace. The nonlinear network program --NLPNETG-- was employed in solving the resulting test cases. This optimization program uses the Truncated-Newton method (quadratic approximation) for determining the search direction at each iteration in the nonlinear algorithm. It was shown that aircraft could be re-routed in an optimal fashion whenever traffic congestion increased beyond an acceptable level, as measured by the nonlinear risk function. B.W.

N86-27272# Massachusetts Inst. of Tech., Lexington.

TCAS EXPERIMENTAL UNIT (TEU) HARDWARE DESCRIPTION

D. A. SPENCER, R. R. LAFREY, J. DIBARTOLO, and W. H. HARMAN 6 Jun. 1986 129 p

(Contract F19628-85-C-0002; DOT-FA77WAI-817)

(FAA/PM-85/2; PR-ATC-133) Avail: NTIS HC A07/MF A01

The hardware design of the TCAS Experimental Units (TEU's) constructed by Lincoln Laboratory to support the design and validation of the Traffic Alert and Collision Avoidance System (TCAS) for the FAA is described. Section 1.0 presents an overview of the operation of the TEU's in order to give some context for the hardware design. References are given to more extensive descriptions of the TCAS system operation and software design. Section 2.0 constitutes the bulk of the report, and is a detailed description of the TEU hardware design. The purpose of this description is to document the design details of the equipment which was used to develop and validate the signal processing techniques and algorithms which appear in the TCAS II Minimum Operational Performance Standard, the TCAS National Standard and various technique reports listed in the references. A second purpose is to provide design guidance to potential TCAS II manufacturers, in the form of a detailed description of a feasible design with documented performance. Finally, this document is a manual for future use and maintenance of the TEU's. Author

N86-27273# Federal Aviation Agency, Atlantic City, N.J.
TECHNICAL SUPPORT OF THE WALL STREET/BATTERY PARK CITY HELIPORT MLS (MICROWAVE LANDING SYSTEM) PROJECT Technical Note, Jan. - Jun. 1985
B. R. BILLMANN, J. H. ENIAS, and M. WEBB Dec. 1985 78 p
(AD-A165073; DOT/FAA/CT-TN85/58) Avail: NTIS HC A05/MF A01 CSCL 17G

During the winter and spring of 1985, the Federal Aviation Administration (FAA) Eastern Region in conjunction with the Guidance and Airborne Systems Branch at the FAA Technical Center conducted a demonstration of a Microwave Landing System (MLS) located at a downtown heliport. This report describes both the industry/user and FAA Technical Center activities during the evaluation period. It describes the evaluation methodology and addresses topics concerning both technical and operational issues. It also describes the helicopter procedures flown during this evaluation and provides an analysis of signal coverage and the user's subjective opinions concerning the acceptability and perceived workload associated with these procedures. It was concluded that MLS to heliports is a viable asset to the helicopter Instrument Flight Rules (IFR) community; however, its full benefits may not be realized in the Battery Park/Wall Street area without revisiting the necessity and demand for the New York Terminal Control Area (TCA) Visual Flight Rules (VFR) operating exclusion area. Author (GRA)

N86-27275# Litton Technische Werke, Freiburg (West Germany).
IMPROVEMENT OF STRAPDOWN SYSTEM PERFORMANCE BY MEANS OF NUMERICAL METHODS Final Report, Dec. 1984
H. BUITKAMP, K. ENDERLEIN, G. EVERETT, U. KIRCHHOFF, M. KLEINSCHMIDT, D. OZDES, and P. STEIERT Bonn Bundesministerium fuer Forschung und Technologie Nov. 1985 130 p In GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie
(BMFT-FB-W-85-011; ISSN-0170-1339; LITEF-105-793) Avail: NTIS HC A07/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 27.50

Software methods to improve the performance of strapdown systems, and the simulation tools used in the analysis of system mechanisms are presented. Models of the inertial and external sensors to compensate for systematic errors; correct timing of the data flow of the sensors; multiposition alignment to eliminate the day-to-day repeatability of gyro biases; design control loops with optimal/suboptimal filters for special tasks of a strapdown unit (e.g., helicopter mission, initial alignment) are described. Kalman filters are used to reduce the influence of stochastic errors and for cross calibration of the sensors. ESA

05

AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

A86-37326
REMOTELY PILOTED VEHICLES; INTERNATIONAL CONFERENCE, 5TH, BRISTOL, ENGLAND, SEPTEMBER 9-11, 1985, PROCEEDINGS AND SUPPLEMENTARY PAPERS
Conference sponsored by the Royal Aeronautical Society and University of Bristol. Bristol, England, University of Bristol, 1985. Proceedings, 174 p.; Supplementary Papers, 87 p. For individual items see A86-37327 to A86-37345.

The present conference gives attention to British Army and Navy RPV requirements, safe mini-RPV operation for civil users, high altitude meteorological RPVs, the British Army's Phoenix battlefield surveillance system, the CL-227 Rotary wing RPV, and the design of compact electromechanical actuators for RPV flight control. Also discussed are a thermal imaging payload for RPV applications, thermal-IR zoom optics for RPV sensors, the Phoenix RPV as sensor turret system, RPV flight testing with a terrain-aided navigation system, the real time simulation of a nonlinear RPV incorporating HUD-type color graphics, a flywheel-powered RPV launcher, and a compressed air-driven RPV launching system. O.C.

A86-37328
THE DEVELOPMENT OF Z-2 REMOTELY PILOTED HELICOPTER
W. X. CHUN (Nanjing Research Institute on Simulation Technique, People's Republic of China) IN: Remotely piloted vehicles; International Conference, 5th, Bristol, England, September 9-11, 1985, Proceedings . Bristol, England, University of Bristol, 1985, p. 6.1-6.12.

Z-2 is a research Remotely Piloted Helicopter (RPH) for feasibility study, developed by Nanjing Research Institute on Simulation Technique (NRIST). It is the first remotely piloted helicopter of 20-30 kg class (T-O weight) developed by the PRC, and success has been obtained in flight tests. This paper describes briefly the Z-2 RPH and its development process, giving informations and analyses, with special emphasis on the designing and building of the composite main rotor blades, the main technical problems encountered and the approaches to solve them, as well as the results of flight tests. Author

A86-37329
HIGH ALTITUDE UNMANNED AIRCRAFT FOR METEOROLOGICAL APPLICATIONS - HIMET
D. W. ALLEN (Theta Analysis and Systems, Ltd., Aldershot, England) and M. C. PUTTOCK (Thorn EMI Electronics, Ltd., Hayes, England) IN: Remotely piloted vehicles; International Conference, 5th, Bristol, England, September 9-11, 1985, Proceedings . Bristol, England, University of Bristol, 1985, p. 7.1-7.17. Research sponsored by the Ministry of Defence (Procurement Executive).

A design configuration study has been conducted for an RPV platform able to carry experimental payloads weighing up to 15 kg to an altitude of 50,000 ft, remaining on station at that altitude for up to 4 h. This RPV, designated 'HIMET', has in the course of the design process been defined with respect to airframe type, propulsion system type, weight budget compliance, and required performance. A turbojet-powered sailplane was ultimately chosen as the HIMET platform. Attention is given to autopilot and control system options, launch and recovery operations, and operational meteorological coverage. O.C.

A86-37330
CANADAIR ROTARY WING, FULL SCALE ENGINEERING DEVELOPMENT. III
R. J. ATKINS (Canadair, Ltd., Montreal, Canada) IN: Remotely piloted vehicles; International Conference, 5th, Bristol, England, September 9-11, 1985, Proceedings . Bristol, England, University of Bristol, 1985, p. 11.1-11.14.

The CL-227 is a rotary wing RPV which is about to enter full scale engineering development. Attention is presently given to the design changes and consequent performance improvements that have accumulated in the course of technology development testing, such as an increase in takeoff mass that has resulted in increased endurance and payload capability. Greater engine output, improved maintainability/reliability, and an enhanced continuous navigation capability are additional consequences of developmental changes in design. O.C.

A86-37338
ENHANCED MISSION VERSATILITY OF THE AQUILA RPV SYSTEM
G. S. MELOY and M. A. LEVIN (Lockheed Missiles and Space Co., Inc., Austin, TX) IN: Remotely piloted vehicles; International Conference, 5th, Bristol, England, September 9-11, 1985, Supplementary Papers . Bristol, England, University of Bristol, 1985, p. 5.1-5.11.

A comprehensive account is given of the development history, design configurations, subsystems integrations, mission profiles,

and performance capabilities of the U.S. Army's Aquila RPV Target Acquisition, Designation and Reconnaissance System. Aquila encompasses such operational capabilities as real time imagery, accurate guidance and navigation at maximum range, a highly stabilized multiple field-of-view payload, an antijam data link, a low observability airframe, and integrated logistics support. Attention is given to the Aquila mission's impact on system cost and complexity, and the spectrum of mission types that can be accommodated in virtue of Aquila's extensive use of modular/exchangeable design features. O.C.

A86-37339
BOEING ROBOTIC AIR VEHICLE
D. E. SLADOVNIK (Boeing Military Airplane Co., Wichita, KS) IN: Remotely piloted vehicles; International Conference, 5th, Bristol, England, September 9-11, 1985, Supplementary Papers . Bristol, England, University of Bristol, 1985, p. 27.1-27.5.

Attention is given to the design features, operational capabilities and mission profiles of the BRAVE-200 Robotic Air Vehicle, which is a low-cost, mission-adaptable minidrone. The mission types encompassed by BRAVE-200's capabilities are destructive and disruptive air defense suppression and battlefield surveillance and reconnaissance. Navigation accuracy, loiter patterns, and mission area performance are all functions of specific mission requirements. O.C.

A86-37340
THE PHOENIX AIR VEHICLE, ITS LAUNCH AND RECOVERY
P. S. TURNER (Flight Refuelling, Ltd., Wimborne, England) IN: Remotely piloted vehicles; International Conference, 5th, Bristol, England, September 9-11, 1985, Supplementary Papers . Bristol, England, University of Bristol, 1985, p. 10.1-10.9.

An account is given to the design features and launch and recovery procedures of the Phoenix RPV, with attention to the way in which simplicity, low detectability and mission criteria influenced design. The Phoenix RPV encompasses a 'taxi' module, comprising the aerodynamic surfaces and controls, engine, electrical generator, and parachute recovery system, on the one hand, and on the other a separate 'mission system pod' module. The advantages of a parachute recovery system are discussed. O.C.

A86-37465
AIRCRAFT ICING OBSERVATIONS AND ANALYSIS
W. SAND (Wyoming, University, Laramie) IN: International Conference on the Aviation Weather System, 2nd, Montreal, Canada, June 19-21, 1985, Preprints . Boston, MA, American Meteorological Society, 1985, p. 94-96.
(Contract USBR-7-07-83-V0001)

An account is given of the results of University of Wyoming aircraft icing effects studies concerned with the location and measurement of supercooled liquid water and with such cloud microphysical parameters as supercooled cloud droplet size spectra. The studies indicate that aircraft climb capability decreases due to icing could be predicted through the examination of the derived parameter designated 'potential accumulation'. Icing effects are illustrated photographically. O.C.

A86-37770* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
FULL-SCALE TILT-ROTOR HOVER PERFORMANCE
F. F. FELKER, M. D. MAISEL, and M. D. BETZINA (NASA, Ames Research Center, Moffett Field, CA) American Helicopter Society, Journal (ISSN 0002-8711), vol. 31, April 1986, p. 10-18. refs

The hover performance of three full-scale rotors was measured at the Ames Outdoor Aerodynamic Research Facility. The rotors, all designed for tilt-rotor aircraft, were the original metal blades for the XV-15 Tilt Rotor Research Aircraft, a set of composite, advanced technology blades for the XV-15, and a 0.658-scale model of the proposed V-22A Osprey (JVX) rotor. The composite advanced technology blades for the XV-15 were tested with several alternate blade root and blade tip configurations. This paper presents the performance of these three rotors, shows the effects of tip Mach number and root and tip configuration changes on rotor performance, and presents data on rotor wake velocity distributions and tip vortex geometry. Measured rotor performance is compared with theoretical predictions, and the discrepancies are discussed. Author

A86-37772* Maryland Univ., College Park.
GUST RESPONSE OF HINGELESS ROTORS
G. S. BIR and I. CHOPRA (Maryland, University, College Park) American Helicopter Society, Journal (ISSN 0002-8711), vol. 31, April 1986, p. 33-46. refs
(Contract NAG1-375)

The gust response of a coupled hingeless rotor-fuselage system is studied in both hover and forward flight. Each rotor blade undergoes flap bending, lag bending, and torsional deflections. The blades are discretized into beam elements, each with fifteen nodal degrees of freedom. The fuselage is permitted three translational (vertical, longitudinal, and lateral) and two rotational (pitch and roll) degrees of freedom. The formulation considers a three-dimensional gust field wherein each gust velocity component can have an arbitrary variation in space and time. Aerodynamic loads are obtained using quasisteady strip theory. Wake-induced effects are introduced through dynamic inflow modeling. Dynamic stall and reverse flow effects are also included. Equations governing the rotor-fuselage gust response are linearized about the vehicle propulsive trim state and the blade steady-state defected positions, and solved by time integration. The effects of several parameters on the helicopter gust response are illustrated, including dynamic inflow, lag stiffness, forward speed, gust profile, gust penetration rate, and gust velocity direction. Author

A86-37773
EFFECTIVENESS OF CURRENT DYNAMIC-INFLOW MODELS IN HOVER AND FORWARD FLIGHT
G. H. GAONKAR (Florida Atlantic University, Boca Raton) and D. A. PETERS (Georgia Institute of Technology, Atlanta) American Helicopter Society, Journal (ISSN 0002-8711), vol. 31, April 1986, p. 47-57. refs
(Contract DAAG29-80-C-0092)

A brief overview of dynamic inflow theory is given, including its history and its dependence on experimental data. Some of the most extensive of this data, flapping response derivatives obtained in 1972-1974, indicated that theoretical predictions which included the best dynamic-inflow models of that time were qualitatively as well as quantitatively inaccurate. In this paper, these original flapping data (some of which have never been compared to theory in the literature) are compared with theory which includes a more recently developed model of dynamic inflow. The correlation is excellent at most frequencies and advance ratios, and the new model brings the theory into qualitative agreement with experiment in all conditions. Author

A86-37774
A UNIFIED FORMULATION OF ROTOR LOAD PREDICTION METHODS
R. E. HANSFORD (Westland Helicopters, Ltd., Yeovil, England) American Helicopter Society, Journal (ISSN 0002-8711), vol. 31, April 1986, p. 58-65. refs

The relative merits and limitations of the Modal Summation and Force Integration approaches to rotor load calculations are discussed. A simple analysis, called the Unified Formulation Method, is devised which converts a Modal Summation approach into Force Integration when necessary. Application to lag damper modeling resulted in an improved correlation of edgewise bending moments near the blade root. Further use of this method is demonstrated for load calculations of higher mode torsional forcings induced by varying pitching moments of advanced multiprofile blades. Author

A86-37807#

AERODYNAMICS AND RADAR-SIGNATURE - A THEORETICAL APPROACH TO ESTIMATE THE RADAR-SIGNATURE OF COMPLEX AIRCRAFT CONFIGURATIONS COMPATIBLE WITH AERODYNAMIC PANEL-METHODS

S. M. HITZEL (Dornier GmbH, Friedrichshafen, West Germany) IN: Applied Aerodynamics Conference, 4th, San Diego, CA, June 9-11, 1986, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1986, p. 46-52. refs

(AIAA PAPER 86-1770)

Combat-aircraft are threatened by radar-controlled anti-aircraft systems. Reduced radar-signature is a means to improve the capabilities to penetrate enemy defense systems. The knowledge of the back-scatter of electromagnetic waves from aircraft makes it possible to design a low radar-signature or at least to improve the tactics of aircraft already in service to avoid successful energy defence reaction. A theoretical approach is presented to estimate the radar-signatures of complex military aircraft-configurations including external stores. The signature is evaluated by the determination of the radar-cross-sections of intended radar-observation-directions. The radar-cross-section of a certain aspect view of a radar-observation is determined by the means of a combination of specular geometrical and physical optics with the evaluation of the radar-reflection characteristics of configuration elements being small compared to the radar's wave-length. The geometric input is equal to the build-up of usual aerodynamic panel-methods. Thus an aerodynamic surface-discretization can be used without modification. The signature of a fighter aircraft, armed and unarmed, exposed to typical radar illumination is presented. Author

A86-37813*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

WIND TUNNEL TEST OF A MODEL ROTOR WITH A FREE-TIP

R. H. STROUB (NASA, Ames Research Center, Moffett Field, CA), H. KUMAGAI (University of Kansas Center for Research, Inc., Lawrence), and C. KEYS (Boeing Vertol Co., Philadelphia, PA) IN: Applied Aerodynamics Conference, 4th, San Diego, CA, June 9-11, 1986, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1986, p. 97-109.

(AIAA PAPER 86-1781)

A model helicopter rotor with a free tip was tested in a wind tunnel to show the effect of the free tip on rotor performance and oscillatory loads. The free-tip rotor has blade tips that are free to pitch independently of the remainder of the blade. A nearly constant pitching moment is applied to the tip so the tip will produce a nearly steady lift around the azimuth. The aerodynamic development of the free tip is reviewed. The development process concentrated on configuring the tip to have the capability of fast response to angle-of-attack perturbations. Wind tunnel test results show the free-tip rotor configuration requires less power than a fixed-tip configuration in forward flight. In addition, the free tip causes substantial reduction in blade-flapwise vibratory loads. However, blade-chordwise loads were increased. Pitch-link vibratory loads were also reduced by the free-tip configuration. Discussion is presented on the reasons that the use of the free tip caused reduced power and smaller vibratory loads. Author

A86-37814*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

EXPERIMENTAL INVESTIGATION OF ROTORCRAFT HUB AND SHAFT FAIRING DRAG REDUCTION

L. A. YOUNG and D. R. GRAHAM (NASA, Ames Research Center, Moffett Field, CA) IN: Applied Aerodynamics Conference, 4th, San Diego, CA, June 9-11, 1986, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1986, p. 110-123. refs

(AIAA PAPER 86-1783)

A wind-tunnel test was conducted to obtain data on several rotorcraft hub and shaft fairing drag reduction configurations. Aerodynamic loads and moments were acquired for each test configuration. Limited wake pressure measurements and flow visualization (tuft) photographs were obtained for some configurations. All hub and shaft fairing configurations were tested on a 1/5-scale XH-59A model fuselage. Both coaxial and single rotor configurations were tested. All rotor assemblies were modeled with nonrotating hardware. The drag reduction methods tested included cambered elliptical hub fairings, several different shaft fairings, and strakes. Test data show that significant drag reductions can be attained with certain fairing configurations. The lowest drag values for the single rotor configurations were obtained for a cambered elliptical hub fairing with a large thickness airfoil shaft fairing. The lowest coaxial configuration drag values were obtained with cambered elliptical hub fairings and a long chord intermediate shaft fairing. Author

A86-37843*# Grumman Aerospace Corp., Bethpage, N.Y.

APPLICATION OF NCOREL TO AIRCRAFT CONFIGURATIONS

M. J. SICLARI (Grumman Corporate Research Center, Bethpage, NY) and J. L. PITTMAN (NASA, Langley Research Center, Hampton, VA) IN: Applied Aerodynamics Conference, 4th, San Diego, CA, June 9-11, 1986, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1986, p. 355-367. refs

(Contract NAS1-16758)

(AIAA PAPER 86-1830)

The NCOREL computer program and methodology (Grossman, 1979) modified for computation of flows over complex geometries is described. The newly introduced features include a more flexible grid-generation package, capable of generating grids for realistic wing-body cross sections, and a more general numerical method, developed for the capture of highly three-dimensional embedded, oblique shocks. In addition, an inlet capability is included, by means of which the cross section is allowed to change discontinuously with the addition of the inlet geometry. The new cross section is regridded and the potentials and their derivatives are interpolated for the marching to continue. Hence, a discontinuity in the grid or mappings is taken into account at the inlet station. The results of the flow-field computation for a realistic fighter configuration are discussed. I.S.

A86-37849#

EULER CALCULATIONS FOR FLOWFIELD OF A HELICOPTER ROTOR IN HOVER

R. K. AGARWAL and J. E. DEESE (McDonnell Douglas Research Laboratories, St. Louis, MO) IN: Applied Aerodynamics Conference, 4th, San Diego, CA, June 9-11, 1986, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1986, p. 425-433. Research sponsored by the McDonnell Douglas Independent Research and Development Program. refs

(AIAA PAPER 86-1782)

Aerodynamic loads on a multibladed helicopter rotor in hovering flight are calculated by solving the three-dimensional Euler equations in a rotating coordinate system on body-conforming curvilinear grids around the blades. Euler equations are recast in the absolute flow variables so that the absolute flow in the far field is uniform but the relative flow is nonuniform. Equations are solved for the absolute flow variables employing Jameson's finite-volume explicit Runge-Kutta time-stepping scheme. Rotor-wake effects are modeled in the form of a correction applied to the geometric angle of attack along the blades. This correction is obtained by computing the local induced downwash with a free-wake analysis program. The calculations are performed on a CRAY X/MP-48 for a model helicopter rotor in hover at various collective pitch angles. The results are compared with experimental data. Author

A86-37939

EAP - FIGHTER BLUEPRINT

G. WARWICK and T. HALL Flight International (ISSN 0015-3710), vol. 129, April 19, 1986, p. 25-30.

The EAP high-performance fighter aircraft, designed by Great Britain for flight this year, is described in detail. EAP is a single-seat delta-canard aircraft powered by two extended-reheat Turbo-Union RB. 199s. The design emphasis is on air-combat performance; attention is therefore focused on attained sustained turn rates

and specific excess power. EAP represents a compromise between the design requirements of both beyond-visual-range and close-in combat. Pitch control is provided by the all-moving foreplane and wing trailing-edge flaperons programmed with airspeed and angle of attack. Roll control is provided by the flaperons which are fully spanned at moderate speed and inboard only at high speed. Since it is designed for angles of attack up to 30 degrees, the EAP has a chin (air) intake with a unique hinged lowerlip. Aside from this high-angle-of-attack, EAP is also capable of transonic acceleration, supersonic flight and short landing. One of the areas to be investigated is the reduction of aircraft infrared and radar cross-sections so as to escape early detection. It is concluded that the EAP is both fast-reacting and easily maneuverable. K.K.

A86-38303

HAWK - THE BRITISH FIGHTING TRAINER

K. G. HODSON (British Aerospace, PLC, Surrey, England) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 34 p.
(SAE PAPER 851768)

A development history is presented for the Hawk family of advanced jet trainer and attack aircraft, whose primary goals have been the achievement of low life cycle and acquisition costs, low fuel consumption, high reliability and structural integrity, and ease of maintenance and manufacture. Attention is given to design development program management lessons learned, the criteria used in choosing among alternative airframe configurations, and the weapons packages used by attack versions of the trainer. O.C.

A86-38304

THE EMB-312 TUCANO - A BRAZILIAN TRAINER

O. SILVA (Embraer-Empresa Brasileira de Aeronautica, S. A., Sao Jose dos Campos, Brazil) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 14 p.
(SAE PAPER 851769)

The design of the EMB-312 Tucano Brazilian advanced trainer is described. The high performance trainer is a low-wing monoplane with a single turboprop engine. The structure of the aircraft is a 2024 Al alloy stressed-skin type with wings and empennage in cantilever construction. The components and operation of the fuel, hydraulic, electrical and avionics systems of the trainer are examined. The advantages provided by the jetlike characteristics of the engine, single throttle lever, ejection seat, and staggered tandem cockpit seats of the trainer are discussed. The performance and fatigue life of the aircraft are evaluated; the trainer displays excellent aerobatic capabilities and a safe service-life of 6000 hours. I.F.

A86-38307

X-WING - A LOW DISC-LOADING V/STOL FOR THE NAVY

J. C. BIGGERS (David W. Taylor Naval Ship Research and Development Center, Bethesda, MD) and A. W. LINDEN (United Technologies Corp., Sikorsky Aircraft Div., Stratford, CT) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 17 p. refs
(SAE PAPER 851772)

The X-wing concept used in the design of the NASA/Army Rotor Systems Research Aircraft (RSRA) rotor wing is described. The X-wing VTOL concept uses a helicopter-like rotor system, but stops the rotor/wing in flight and uses it as the fixed wing. The major elements in the RSRA/X-wing project are the rotor/wing system, the fly-by-wire control system, the compressor supplying the Coanda blowing air, and the modifications to the RSRA drive train. The X-wing can provide one aircraft with fixed-wing cruise efficiency, helicopter-like hover efficiency and hover control power, 0 to 300-knot one-engine inoperative capability and acceptable empty weight/gross weight ratios. I.S.

A86-38325* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

LEADING-EDGE DESIGN FOR IMPROVED SPIN RESISTANCE OF WINGS INCORPORATING CONVENTIONAL AND ADVANCED AIRFOILS

H. P. STOUGH, III, F. L. JORDAN, JR., D. J. DICARLO, and K. E. GLOVER (NASA, Langley Research Center, Hampton, VA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 17 p. refs
(SAE PAPER 851816)

Discontinuous wing leading-edge droop designs have been evaluated as a means of modifying wing autorotative characteristics and thus improving airplane spin resistance. Addition of a discontinuous outboard wing leading-edge droop to three typical light airplanes having NACA 6-series wing sections produced significant improvements in stall characteristics and spin resistance. Wind tunnel tests of two wings having advanced natural laminar flow airfoil sections indicated that a discontinuous leading-edge droop can delay the onset of autorotation at high angles of attack without adversely affecting the development of laminar flow at cruise angles of attack. Author

A86-38336* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

THE STOL PERFORMANCE OF A TWO-ENGINE, USB POWERED-LIFT AIRCRAFT WITH CROSS-SHAFTED FANS

V. C. STEVENS, S. B. WILSON, III (NASA, Ames Research Center, Moffett Field, CA), and C. A. ZOLA (NASA, Lewis Research Center, Cleveland, OH) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 8 p.
(SAE PAPER 851839)

The short takeoff and landing capabilities that characterize the performance of powered-lift aircraft are dependent on engine thrust and are, therefore, severely affected by loss of an engine. This paper shows that the effects of engine loss on the short takeoff and landing performance of powered-lift aircraft can be effectively mitigated by cross-shafting the engine fans in a twin-engine configuration. Engine-out takeoff and landing performances are compared for three powered-lift aircraft configurations: one with four engines, one with two engines, and one with two engines in which the fans are cross-shafted. The results show that the engine-out takeoff and landing performance of the cross-shafted two-engine configuration is significantly better than that of the two-engine configuration without cross-shafting. Author

A86-38337

REQUIREMENTS FOR FUTURE RALS/STOVL OPERATING CONCEPTS

D. J. MCNALLY and D. M. BROWN (Northrop Corp., Aircraft Div., Hawthorne, CA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 9 p.
(SAE PAPER 851840)

The particular application of the Remote Augmented Lift System (RALS) to tactical short take-off, vertical landing (STOVL) aircraft enables configurations to be designed that possess significant supersonic performance in addition to subsonic/transonic performance. Future tactical fighter aircraft for the 1995 time frame should be flexible enough to cover various roles, e.g., close air support (CAS)/battlefield air interdiction (BAI), and have significant air-to-air capability with rapid redeployment potential in the face of a changing battle scenario. In addition, these aircraft must possess superior lethality, survivability and availability characteristics. STOVL concepts make a distinct contribution to availability by virtue of allowing remote austere basing operations. Recent operational studies have identified new requirements for basing, support, and new technologies that could greatly improve sortie generation capability. This paper discusses requirements for a RALS/STOVL concept operating in this environment. Author

A86-38338* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

THE IMPACT OF TECHNOLOGY ON FIGHTER AIRCRAFT REQUIREMENTS

S. M. DOLLYHIGH and W. E. FOSS, JR. (NASA, Langley Research Center, Hampton, VA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 10 p.
(SAE PAPER 851841)

Technology integration studies were made to examine the impact of emerging technologies on fighter aircraft. The technologies examined included advances in aerodynamics, controls, structures, propulsion, and systems and were those which appeared capable of being ready for application by the turn of the century. A primary impetus behind large increases in figher capability will be the rapid increase in fighter engine thrust-to-weight ratio. High thrust-weight engines, integrated with other advanced and emerging technologies, can result in small extremely maneuverable fighter aircraft that have thrust-weight ratios of 1.4+ and weight one-half as much as today's fighters. Future fighter aircraft requirements are likely to include a turn capability in excess of 7g's throughout much of the maneuver envelope, post-stall maneuverability, STOVL or VTOL, and a single engine for low cost. Author

A86-38339* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

ESTIMATION OF LIFT LOSSES OF HOVERING VEHICLES USING A SINGLE JET

R. S. CHRISTIANSEN, L. K. MITCHELL, and J. E. ESHLEMAN (NASA, Ames Research Center, Moffett Field, CA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 9 p. refs
(SAE PAPER 851842)

This paper discusses the development of handbook techniques for the preliminary assessment of V/STOL aircraft performance while hovering in the proximity of the ground. In particular, the suckdown forces due to entrainment are described for configurations using a single jet. Corrections to current methods are suggested from an analysis of recent large-scale test data. Author

A86-38340* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

EFFECTS OF JET FLAP ON AV8-B 'HARRIER' PERFORMANCE

A. S. HAHN and S. B. WILSON, III (NASA, Ames Research Center, Moffett Field, CA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 45 p. refs
(SAE PAPER 851843)

This paper examines the effects of fitting various jet-flap configurations to an AV8-'Harrier II' Baseline aircraft using two NASA developed computer codes. The first code predicts the ground roll of an AV8-B with a partial span jet-flap, a full span jet-flap, a partial span internally blown-flap, and a full span internally blown-flap as well as the Baseline configuration. The second code used was a mission performance estimation routine called ACSYNT (Aircraft Synthesis). This code models each configuration on a standard mission so that the relative merits may be determined. Author

A86-38341

FOLDING TILTROTOR TECHNOLOGY DEMONSTRATOR - THE NEXT STEP FOR TILTROTOR TECHNOLOGY

D. P. GLEITER (Boeing Vertol Co., Philadelphia, PA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 8 p. refs
(SAE PAPER 851844)

Based on a comparative study of competing V/STOL concepts, the folding tiltrotor offers many advantages for missions requiring long endurance combined with a speed capability in excess of 400 knots. Folding tiltrotor technology development began in 1967 and the results of wind tunnel tests and design studies show no significant technical obstacles to the development of a folding tiltrotor aircraft. The convertible fan/shaft CTFS-34 engine can be used to power a technology demonstrator aircraft. The next step in the development of tiltrotor technology should be a folding tiltrotor technology demonstrator based on either the V-22 or the S-3A. Author

A86-38342

RESULTS OF PILOTED SIMULATION OF GRUMMAN DESIGN 698

J. W. CLARK, JR., S. T. DONLEY, and J. B. JOHNS (U.S. Navy, Naval Air Development Center, Warminster, PA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 14 p.
(SAE PAPER 851846)

The third in a series of three piloted simulations of the Grumman Design 698 Tilt-Fan V/STOL Demonstrator was conducted at NASA Ames Research Center on the Vertical Motion Simulator. Both single-engine-failure characteristics (with and without engine cross-shafting) and hover/low-speed handling qualities were investigated. Based on minimum recovery speed, altitude loss, and ejection capability following a single engine failure, the cross-shafted configuration offers a substantial increase in flight safety over the non-cross-shafted configuration. Based on handling qualities ratings, touchdown performance, and pilot comments, attitude command/attitude hold or translational rate command/translational rate hold response type control systems yield satisfactory handling qualities during shipboard terminal operations. Author

A86-38349* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

HARRIER III-AV8B WITH A MODERN ENGINE

S. B. WILSON, III (NASA, Ames Research Center, Moffett Field, CA) and J. M. WURTS (California Polytechnic State University, San Louis Obispo, CA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 14 p. refs
(SAE PAPER 851881)

The paper examines the application of a 26, 156-lb thrust engine (which is 30 percent more thrust than the short-lift dry rating on the F402-RR-406 Pegasus engine) to an AV-8B aircraft. This modern engine has 30 percent more thrust than the F402-RR-406 Pegasus engine with no increase in engine weight; the weight is assumed to be constant for both engines. The paper focuses on the benefit to the AV-8B in increasing short takeoff gross weight and vertical landing weight. A second comparison is made between the bigger engine with the existing thrust-versus-SFC curve, and a 10 percent lower SFC curve. The notion of a modern engine with 10 percent lower SFC and 30 percent more thrust for the same size and weight is presented as a hypothesis, and is not supported by discussing engine technology. There are no engine data or technical discussion as to how the modern engine is constructed or which manufacturer could build it. The performance estimates are generated by ACSYNT, a NASA developed computer code that is available to U.S. industry and has been reported on in a number of other publications. Author

A86-38350

THE SIGNIFICANCE OF ADVANCED TECHNOLOGY ENGINES ON V/STOL SYSTEMS

G. PERKINS (United Technologies Corp., Pratt and Whitney, East Hartford, CT) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 7 p.
(SAE PAPER 851882)

An evaluation is made of the development status of next-generation engines offering improved specific thrust and fuel consumption for military V/STOL aircraft, with attention to the design configuration and advanced components technologies incorporated by the engines. Emerging engine technologies encompass metal matrix composites for fans, higher compressor stage loadings, digital control systems, carbon-carbon composite hot section components, and improved turbine blade cooling. Thrust/weight, specific excess power, takeoff gross weight, and life cycle cost trends are discussed. O.C.

A86-38355
TRANSPORT AIRCRAFT CRASHWORTHINESS REQUIREMENTS - AN INDUSTRY VIEW
W. W. BINGHAM (Boeing Commercial Airplane Co., Seattle, WA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 9 p.
(SAE PAPER 851888)

This paper reviews past design and operational achievements that minimize those conditions identified as prime in contributing to transport aircraft accidents. Recent history of survivable accidents is then examined to identify the critical sequences leading to the most frequent and/or serious accidents. Finally, existing and anticipated near-term advances in aircraft production technology that may eliminate the chain of events identified above as critical in accident scenarios are reviewed. Author

A86-38362
A VERIFICATION OF PROPULSION AND AIRPLANE PERFORMANCE MODELS GENERATED FROM FLIGHT
P. V. DONLAN (Kohlman Systems Research, Inc., Lawrence, KS) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 8 p.
(SAE PAPER 851899)

Performance modeling is a process where a representative nominal engine model is calibrated to the test engines as installed on the test airplane. Research initiated by Schweikhard and Marshall at NASA and further developed at the University of Kansas has shown that performance modeling is a viable and inexpensive alternative to in-flight thrust measurements or calibrated engines. Testing using this method has been performed on twelve business jets. On one of these programs, both calibrated engines and a nominal engine model were available; thus verification of performance modeling was possible. Through this verification process it was shown that similar drag polars resulted from the two methods. A difference in drag was found to be no greater than 20 counts. This paper describes the methods used for the performance modeling, which includes propulsion modeling methods and flight test procedures. The resulting flight test data are presented. Author

A86-38364
NONFLAMMABLE FLUID AND 8,000 PSI TECHNOLOGY FOR FUTURE AIRCRAFT HYDRAULIC SYSTEMS (22 CFR 125.4 /B/ /13/ APPLICABLE)
K. E. BINNS, W. B. CAMPBELL (USAF, Wright-Patterson AFB, OH), N. J. PIERCE, and R. E. YOUNG (McDonnell Aircraft Co., St. Louis, MO) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 14 p.
(SAE PAPER 851909)

In the middle 1970s, the Air Force identified significant damage and losses due to noncombat hydraulic fluid fires. As a result of these fires, a search for a nonflammable hydraulic fluid for use in new aircraft was initiated. A nonflammable fluid, chlorotrifluoroethylene, was identified. However, its weight was over 2.2 times heavier than conventional fluid. This paper discusses the system design approaches, component design, and test results of an overall program to establish technology for use of this nonflammable fluid in new aircraft. This includes the tradeoff study results for selection of 8000 psi as the pressure level, design approaches to control water hammer pressures, component and system design and evaluation. The status of ongoing programs for investigating dynamic seals, pumps, and low energy consumption hydraulic concepts is also presented. Author

A86-38365
LIGHTWEIGHT HYDRAULIC SYSTEM TECHNOLOGY - 8000 PSI UPDATE
W. N. BICKEL (Rockwell International Corp., Columbus, OH) and J. OHLSON (U.S. Navy, Naval Air Development Center, Warminster, PA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 10 p.
(SAE PAPER 851910)

The use of higher operating pressures (8000 psi) in aircraft fluid systems is examined. The initial development, computer simulation, laboratory testing, and flight testing of the lightweight hydraulic system (LHS) are discussed. The compatibility testing and full-scale A-7E simulator evaluation of the actuators, actuator dynamic rod and piston seals, axial-piston pumps, titanium tubing, and servo valves of the full-scale LHS are described. The reliability, maintainability, and safety of the LHS are evaluated. Cost analysis of the system reveals that operating an aircraft with an 8000 LHS reduces the weight of the system by 30 percent and the volume by 40 percent as compared to the 3000 psi system. I.F.

A86-38366
HYDRAULIC PUMPS FOR HIGH PRESSURE NON-FLAMMABLE FLUIDS
J. A. HALAT (Vickers, Inc., Jackson, MS) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 11 p.
(SAE PAPER 851911)

Design considerations that 8000-psi and nonflammable fluids have upon an aircraft inline piston hydraulic pump are presented. The influence of the major physical properties of one nonflammable fluid, chlorotrifluoroethylene (CTFE), are discussed as well as the influence of the hydraulic system. Hydraulic pump pressure, based on experience with the U.S. Navy Lightweight Hydraulic System (LHS), can be increased to 8000 psi without encountering major problems. Utilization of CTFE as a hydraulic fluid shows considerable promise. The performance characteristics of an 8000-psi pump are presented. The paper includes a summary of high pressure operating experience. The paper concludes with a summary of the Wright Patterson Air Force Base Contract for three 40-gpm, 8000-psi CTFE pumps. Author

A86-38367
8000 PSI HYDRAULIC SYSTEM SEALS AND MATERIALS TEST PROGRAM - A PROGRESS REPORT
R. V. FLIPPO (HR Textron, Inc., Valencia, CA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 18 p.
(SAE PAPER 851913)

Flight control technology for 8000 psi has emerged almost simultaneously with new fire-resistant hydraulic fluids, such as MIL-H-83282 and chlorotrifluoroethylene. A proliferation of industry recommendations has resulted in a wide variety of mechanisms for solving associated actuator design problems, including tighter clearances, special seals, finishes, materials, and many others. As there are few common agreements on the issues, an extensive three-phase test program was undertaken to attempt to corroborate some of these approaches, or to suggest others that may be better or more cost effective. Author

A86-38369
AIRCRAFT FLOTATION ANALYSIS - CURRENT METHODS AND PERSPECTIVE
N. S. CURREY (Lockheed-Georgia Co., Marietta, GA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 13 p. refs
(SAE PAPER 851936)

Current methods of aircraft flotation analysis, i.e., analysis of an aircraft's ability to operate on an airfield surface of defined strength, are presented, together with the upcoming ICAO's ACN/PCN (aircraft classification number/pavement classification number) classification system. Flotation terminology and flotation parameters are defined. The Load Classification Number and the Load Classification Group methods of flotation analysis, adopted

in the past by the ICAO, are compared. Analysis methods recommended for military and for commercial usage are listed.
I.S.

A86-38372* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
THE GENERATION OF TIRE CORNERING FORCES IN AIRCRAFT WITH A FREE-SWIVELING NOSE GEAR
R. H. DAUGHERTY and S. M. STUBBS (NASA, Langley Research Center, Hampton, VA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 9 p. Previously announced in STAR as N86-11522. refs
(SAE PAPER 851939)

An experimental investigation was conducted to study the effect of various parameters on the cornering forces produced by a rolling aircraft tire installed on a tilted, free-swiveling nose gear. The parameters studied included tilt angle, trial, tire inflation pressure, rake angle, vertical load, and whether or not a twin tire configuration corotates. These parameters were evaluated by measuring the cornering force produced by an aircraft tire installed on the nose gear of a modified vehicle as it was towed slowly. Cornering force coefficient increased with increasing tilt angle. Increasing trial or rake angle decreased the magnitude of the cornering force coefficient. Tire inflation pressure had no effect on the cornering force coefficient. Increasing vertical load decreased the cornering force coefficient. When the tires of a twin tire system rotated independently, the cornering force coefficients were the same as those for the single-tire configuration. When the twin tire system was made to corotate, however, the cornering force coefficients increased significantly. Author

A86-38373
EUROPEAN AIRCRAFT STEERING SYSTEMS
D. W. S. YOUNG (Dowty Rotol, Ltd., Gloucester, England) and B. OHLY (Messerschmitt-Boelkow-Blohm GmbH, Munich, West Germany) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 16 p.
(SAE PAPER 851940)

The paper discusses system and hardware design characteristics of the steering for several current aircraft and aircraft under development, covering both mechanically and electronically controlled systems. Possible future developments for steering systems are discussed briefly. Author

A86-38374
INTEGRATED BRAKING AND GROUND DIRECTIONAL CONTROL FOR TACTICAL AIRCRAFT
K. L. SMITH, C. L. DYER (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH), and S. M. WARREN (Boeing Military Airplane Co., Wichita, KS) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 16 p.
(SAE PAPER 851941)

An autonomous ground handling system is being developed that integrates and automatically controls selected aircraft functions, such as the rudder, brakes, and nose wheel steering, to prevent Air Force aircraft from veering off runways during adverse weather operations. The system uses only aircraft-generated signals and pilot inputs to control the lateral forces on the aircraft and keep it on the runway centerline. Piloted simulations of an F-4 equipped with the system indicate that it can extend the crosswind landing capability of the aircraft into a region designated 'unsafe' by the flight manual. Author

A86-38375
THE HISTORY AND DEVELOPMENT OF THE REPEATABLE RELEASE CATAPULT HOLDBACK BAR
J. D. HELM (Decoto Aircraft, Inc., Yakima, WA) and H. H. PERRY SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 24 p.
(SAE PAPER 851942)

A holdback and release device is generally used to restrain an aircraft prior to catapulting. For many years release was effected by rupture of a replaceable, frangible link in the release device. While this system is conceptually simple, it has many operational and logistic drawbacks. This paper describes the history and successful development of a reuseable, or repeatable release catapult holdback system as presently used on the F-14, F-18 and T-45. Author

A86-38501
GENERAL AVIATION AIRCRAFT AERODYNAMICS; PROCEEDINGS OF THE GENERAL AVIATION AIRCRAFT MEETING AND EXPOSITION, WICHITA, KS, APRIL 16-19, 1985
Meeting and Exposition sponsored by SAE. Warrendale, PA, Society of Automotive Engineers, Inc. (SAE SP-621), 1985, 104 p. For individual items see A86-38502 to A86-38508.
(SAE SP-621)

The present conference considers propeller slipstream effects on a laminar wing boundary layer, the flight test evaluation of a laminar wing insect contamination protection system, experimental study results for a general aviation single-engine aircraft with natural flow wings, natural laminar boundary layer flow flight test experiment results, and the manufacturing tolerance requirements of laminar flow airframe surfaces. Also discussed are natural laminar flow conditions obtainable for regional commuter aircraft, the independence of parameters that are important to the design of subsonic canard-configured aircraft, analytical study results for three-surface lifting systems, and an application of the Carson (1982) cruise optimum airspeed compromise between speed and efficiency. O.C.

A86-38504* Wichita State Univ., Kans.
FURTHER RESULTS OF NATURAL LAMINAR FLOW FLIGHT TEST EXPERIMENTS
W. H. WENTZ, JR., A. AHMED (Wichita State University, KS), and R. NYENHUIS (Cessna Aircraft Co., Wichita, KS) IN: General aviation aircraft aerodynamics; Proceedings of the General Aviation Aircraft Meeting and Exposition, Wichita, KS, April 16-19, 1985 . Warrendale, PA, Society of Automotive Engineers, Inc., 1985, p. 37-50. refs
(Contract NAG1-104)
(SAE PAPER 850862)

Flight test experiments were conducted to measure the extent and nature of natural laminar flow on a smoothed test region of a swept-wing business jet wing. Surface hot film anemometry and sublimating chemicals were used for transition detection. Surface pressure distributions were measured using pressure belts. Engine noise was monitored by a microphone attached to the wing surface to study possible acoustic effects on stability of the laminar boundary layer. Side-slip conditions were flown to simulate changes in effective wing sweep. Flight instrumentation and ground data analysis techniques and a method for measuring intermittency of turbulence are described. Correlation was obtained between the hot film gage signals and chemicals for transition detection. Cross-flow vortices were observed for some flight conditions. Results of spectral and statistical analysis of the hot film signals for various flight test conditions are presented. Author

A86-38506*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
INTERDEPENDENCE OF PARAMETERS IMPORTANT TO THE DESIGN OF SUBSONIC CANARD-CONFIGURED AIRCRAFT
T. W. FEISTEL (NASA, Ames Research Center, Moffett Field, CA) IN: General aviation aircraft aerodynamics; Proceedings of the General Aviation Aircraft Meeting and Exposition, Wichita, KS, April 16-19, 1985 . Warrendale, PA, Society of Automotive Engineers, Inc., 1985, p. 73-83. refs
(SAE PAPER 850865)

An analysis is made of the interrelationship of the longitudinal parameters important to the aerodynamic design of an efficient canard or tandem wing configuration. It is shown that theoretical configuration span efficiencies substantially greater than one are feasible with the proper choice of parameters. This improvement can translate into significantly increased lift/drag ratios assuming fixed spans. The Prandtl-Munk relationship for induced drag is

used as a convenient qualitative guide, with stability and trim criteria superimposed. An 'aspect-ratio ratio' parameter is introduced to aid in optimizing a configuration longitudinally. It is shown that a canard/wing 'aspect-ratio ratio' of approximately 3/2 to 2 is necessary to achieve peak span efficiency for a given span ratio and gap, assuming representative parameters. Author

A86-38508

AN APPLICATION OF THE CARSON CRUISE OPTIMUM AIRSPEED - A COMPROMISE BETWEEN SPEED AND EFFICIENCY

H. C. SMITH (Pennsylvania State University, University Park) IN: General aviation aircraft aerodynamics; Proceedings of the General Aviation Aircraft Meeting and Exposition, Wichita, KS, April 16-19, 1985 . Warrendale, PA, Society of Automotive Engineers, Inc., 1985, p. 95-99.

(SAE PAPER 850867)

It is well known that, for propeller-driven airplanes, maximum fuel economy occurs at maximum L/D ratio. It has been shown that, while the speed for maximum L/D yields the least fuel consumed per unit of distance, there is also a speed for the least fuel per unit of velocity, essentially, the best compromise between speed and fuel economy. This paper presents a simple method to predict this optimum airspeed in terms of calibrated airspeed. In this form, it is only a function of gross weight and could easily be made available in operating handbooks in the form of two-dimensional charts. It is shown that the optimum airspeeds for the range of normal operating gross weights requires fairly normal cruise power settings. The study further describes a simple, straightforward method of arriving at the relationship of cruise optimum airspeed in terms of maximum L/D speed. Author

A86-38509

CRASH DYNAMICS OF GENERAL AVIATION AIRCRAFT; PROCEEDINGS OF THE GENERAL AVIATION AIRCRAFT MEETING AND EXPOSITION, WICHITA, KS, APRIL 16-19, 1985

Meeting and Exposition sponsored by SAE. Warrendale, PA, Society of Automotive Engineers, Inc. (SAE SP-622), 1985, 108 p. For individual items see A86-38510 to A86-38514.

(SAE SP-622)

Papers are presented on formulating criteria to increase passenger safety survivability following small aircraft accidents. Consideration is given to the validation of the seat/occupant model for light aircraft, the development of criteria for general aviation seat and restraint system performance, and human response to impact acceleration. Topics discussed include procedures for evaluating aircraft crash floor pulses, crashworthy design considerations for the general aviation seat, design research for the Caravan 1 crew seat, and the development of mechanical components for advanced aircrew seating systems. I.F.

A86-38513

A PROCEDURE TO EVALUATE AIRCRAFT CRASH FLOOR PULSES

G. WITTLIN (Lockheed-California Co., Burbank) IN: Crash dynamics of general aviation aircraft; Proceedings of the General Aviation Aircraft Meeting and Exposition, Wichita, KS, April 16-19, 1985 . Warrendale, PA, Society of Automotive Engineers, Inc., 1985, p. 55-63. refs

(SAE PAPER 850854)

The paper presents a rational method by which aircraft floor pulses can be defined and their effect on the seat-occupant system evaluated by using the pulses to obtain seat test performance data. The results of recent analyses of a transport airplane exposed to a candidate crash scenario along with seat test data are provided. The results of full-scale crash test analyses of general aviation aircraft are also addressed. It is shown that modeling of aircraft to obtain floor responses can produce a wide range of pulse definitions. It is not always obvious which pulse configuration may be more deleterious to the seat or occupant, without a procedure to compare seat-occupant response. Seat-occupant response evaluation requires that a set of test data and performance criteria parameters be established. Using an analytical approach correlated with test data, provides a basis for such an evaluation. A step-by-step procedure is evolved and comparisons of different pulses are illustrated. Author

A86-38514

PRELIMINARY DESIGN RESEARCH FOR THE CARAVAN 1 CREW SEAT

R. K. RATHGEBER (FAA, Kansas City, KS) and P. E. PARKER (Cessna Aircraft Co., Wichita, KS) IN: Crash dynamics of general aviation aircraft; Proceedings of the General Aviation Aircraft Meeting and Exposition, Wichita, KS, April 16-19, 1985 . Warrendale, PA, Society of Automotive Engineers, Inc., 1985, p. 79-100. refs

(SAE PAPER 850856)

The Cessna Caravan 1 crew seat/restraint system incorporates many new design features. This system is the result of several iterations of development and evaluations using dynamic test procedures. The testing was done at the Protection and Survival Laboratory dynamic impact test track facility of the FAA Civil Aeromedical Institute. The recommendations of the General Aviation Safety Panel influeenced the test procedures and pass/fail criteria for this project. Data from the dynamic tests provided valuable information on features of seat/restraint system design. Author

A86-38515

COMPOSITES: DESIGN AND MANUFACTURING FOR GENERAL AVIATION AIRCRAFT; PROCEEDINGS OF THE GENERAL AVIATION AIRCRAFT MEETING AND EXPOSITION, WICHITA, KS, APRIL 16-19, 1985

Meeting and Exposition sponsored by SAE. Warrendale, PA, Society of Automotive Engineers, Inc. (SAE SP-623), 1985, 95 p. For individual items see A86-38516 to A86-38523.

(SAE SP-623)

The present conference on the design and manufacturing of general aviation aircraft composite structures considers the design and certification of a composite control surface, the application of photostress methods to study stress concentrations in composite structures, the buckling behavior and pertinent design data of laminated composite triangular plates, and stress concentrations at a rectangular cutout in a buffer strip laminate. Also discussed are the design and use of Kevlar reinforcements in aircraft structures, high producibility composites design, a room temperature-capable and high temperature-capable cementitious tooling and molding material, the use of an electroformed nickel mold for use in the manufacture of composite parts, the structural dynamics of electroimpulse deicing of a Kevlar-reinforced composite leading edge, and large amplitude vibrations of composite plates treated by self-generating functions. O.C.

A86-38516

DESIGN AND CERTIFICATION OF A COMPOSITE CONTROL SURFACE

C. W. SCHNEIDER and D. C. GIBSON (Lockheed-Georgia Co., Marietta) IN: Composites: Design and manufacturing for general aviation aircraft; Proceedings of the General Aviation Aircraft Meeting and Exposition, Wichita, KS, April 16-19, 1985 . Warrendale, PA, Society of Automotive Engineers, Inc., 1985, p. 1-8. refs

(SAE PAPER 850888)

The present graphite/epoxy composite rudder was designed, tested and certified to replace the G-III executive jet's conventional skin-stiffened aluminum structure, achieving a 50 percent increase in acoustic fatigue life with 22-percent weight savings. Full scale testing encompassed both static and flight tests. Attention is given to structural subelements' design details; an innovative rib cap design is employed to yield enhanced fatigue and damage resistance. O.C.

A86-38520

DESIGN AND USE OF KEVLAR IN AIRCRAFT STRUCTURES

P. R. LANGSTON (Du Pont de Nemours and Co., Textile Fibers Dept., Wilmington, DE) IN: Composites: Design and manufacturing for general aviation aircraft; Proceedings of the General Aviation Aircraft Meeting and Exposition, Wichita, KS, April 16-19, 1985 . Warrendale, PA, Society of Automotive Engineers, Inc., 1985, p. 41-55.
(SAE PAPER 850893)

Kevlar and Nomex can be applied in the design of aircraft primary structures to reduce weight, lower production costs and life cycle costs, reduce structural maintenance requirements, and increase reliability. Attention is given to Kevlar 49 reinforcing fibers; free vibration decay times, fatigue behavior, moisture absorption, honeycomb sandwich construction applications in conjunction with Nomex cores, and use in filament-wound solid laminates. Applications of these structural methods in A310 and B767 airliners, as well as general aviation, helicopter, and advanced military aircraft, are noted. O.C.

A86-38701

TIME RUNS OUT FOR THE CLOCKWORK COCKPIT

G. WARWICK Flight International (ISSN 0015-3710), vol. 129, April 26, 1986, p. 30-33.

The concept of an electronic cockpit began with the design of a CRT horizontal situation indicator for the 767, which led to an electronic attitude direction indicator, etc. Further integration and simplification of the displays permitted displacement of the flight engineer. Customer demands for the latest in technology spurred further cockpit automation, along with backup analog displays. Synoptic displays have been developed in order to extend the digital display formats, and retain their simplicity, from two-engine aircraft to four-engine aircraft such as the 747-400 under development. Similar upgrades are being introduced into the MD-80 series of aircraft, which will also carry wind shear alert capabilities. Additionally, the MD-88 will have either LCD or LED displays to replace electromechanical gages for engine instruments and fluids displays. Extensive upgrading of the redundant autopilot for the MD-11 will permit the aircraft to take corrective actions in the event of a malfunction. The success of the autopilot, and the basis for the decision to implement such an innovation, is a function of the long experience of the manufacturer with the aircraft. M.S.K.

A86-38721#

AIRCRAFT WHEEL DESIGN AND PROVING

S. M. SMITH (Dunlop Aerospace Group, Coventry, England) Tech Air (ISSN 0040-0831), vol. 44, May 1986, p. 1-4.

The critical design parameters of A-frame and bowl-type wheel designs for aircraft landing gear are summarized. Only the bowl-type design permits installation of heavier brakes, at a concommitant weight penalty, for absorption of higher energy loads. Attention is given to stress-strain prediction for the wheel flange which retains the tire, noting that the possibility of multiple wheel failures on modern transport aircraft has led to the requirement that the wheel rim must be capable of bearing the full load of the aircraft. The necessity of regular tire inspections to detect incipient failure conditions is stressed, along with the inclusion of a fusible device in the tires to prevent blowouts by deflating the tires in the event of overheating or overused brakes. Techniques of photostress analysis of the main wheel diaphragms are described, along with factors influencing the design of the bolt/half hub interface. Titanium and aluminum lithium alloys are noted as potential high-strength, lower-weight materials for wheels to replace magnesium and cast aluminum. Finally, tire testing procedures to ensure that tires meet the specified performance parameters are outlined. M.S.K.

A86-38836*# PRC Kentron, Inc., Hampton, Va.

STRUCTURAL ANALYSIS OF THE CONTROLLED IMPACT DEMONSTRATION OF A JET TRANSPORT AIRPLANE

E. L. FASANELLA (PRC Kentron, Inc., Hampton, VA), E. WIDMAYER (Boeing Commercial Airplane Co., Seattle, WA), and M. P. ROBINSON (NASA, Langley Research Center, Hampton, VA) IN: Structures, Structural Dynamics and Materials Conference, 27th, San Antonio, TX, May 19-21, 1986, Technical Papers. Part 1 . New York, American Institute of Aeronautics and Astronautics, 1986, p. 324-332. refs
(AIAA PAPER 86-0939)

An analytical method has been developed for assessing crash dynamics of large transport aircraft, such as in the NASA Controlled Impact Demonstration (CID) jet crash test on December 1, 1984. The DYCAST nonlinear finite-element computer code was used in a series of progressively more difficult tasks to model complete transport aircraft crashes. Single aircraft frames and fuselage section vertical drop tests were modeled and analyzed to obtain comparisons with experimental data and to develop hybrid element crash springs for use in the large CID model. Predictions of crash and acceleration levels from a symmetric CID model agreed well with data from the CID experiment. I.S.

A86-38837*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

EQUIVALENT PLATE ANALYSIS OF AIRCRAFT WING BOX STRUCTURES WITH GENERAL PLANFORM GEOMETRY

G. L. GILES (NASA, Langley Research Center, Hampton, VA) IN: Structures, Structural Dynamics and Materials Conference, 27th, San Antonio, TX, May 19-21, 1986, Technical Papers. Part 1 . New York, American Institute of Aeronautics and Astronautics, 1986, p. 333-342. refs
(AIAA PAPER 86-0940)

A new equivalent plate analysis formulation is described which is capable of modeling aircraft wing structures with a general planform such as cranked wing boxes. Multiple trapezoidal segments are used to represent such planforms. A Ritz solution technique is used in conjunction with global displacement functions which encompass all the segments. This Ritz solution procedure is implemented efficiently into a computer program so that it can be used by rigorous optimization algorithms for application in early preliminary design. A direct method to interface this structural analysis procedure with aerodynamic programs for use in aeroelastic calculations is described. This equivalent plate analysis procedure is used to calculate the static deflections and stresses and vibration frequencies and modes of an example wing configuration. The numerical results are compared with results from a finite element model of the same configuration to illustrate typical levels of accuracy and computation times resulting from use of this procedure. Author

A86-38840#

OPERATIONAL EXPERIENCE OF U.S. AIR FORCE WITH STRUCTURAL COMPOSITES

T. F. CHRISTIAN, JR., M. K. STOWERS, W. H. SCHWEINBERG, and G. W. OYLER (USAF, Warner Robins Air Logistics Center, Robins AFB, GA) IN: Structures, Structural Dynamics and Materials Conference, 27th, San Antonio, TX, May 19-21, 1986, Technical Papers. Part 1 . New York, American Institute of Aeronautics and Astronautics, 1986, p. 362-365.
(AIAA PAPER 86-0946)

USAF operational experience with composites as primary structures in fighter, transport, and trainer aircraft is described. The advantages and the problems of maintenance of each structure are discussed. The items discussed include the structures and parts made of boron-epoxy and graphite/epoxy laminates, used as skins in the F-15 and F-16, respectively; graphite/fiberglass monolithic leading wing edges and graphite/epoxy/Kevlar skins in C-141; graphite/epoxy wing tip, aileron trailing edge wedge, main landing gear strut door, and wing rib in T-38; and Kevlar/epoxy skins and intercostals, and graphite-reinforced belly skin panel in C-130. The problems associated with nondestructive inspection

and with the effects of moisture were of particular concern in obtaining consistent repairs. I.S.

A86-38846#

INFLUENCE OF FBW - CONTROL LAWS ON STRUCTURAL DESIGN OF MODERN TRANSPORT AIRCRAFT

M. BESCH (Messerschmitt-Boelkow-Blohm GmbH, Hamburg, West Germany) IN: Structures, Structural Dynamics and Materials Conference, 27th, San Antonio, TX, May 19-21, 1986, Technical Papers. Part 1 . New York, American Institute of Aeronautics and Astronautics, 1986, p. 409-420. refs

(AIAA PAPER 86-0953)

The influence of such novel aircraft features as control laws is discussed in the context of an implementation of fly-by-wire and sidestick controller technologies satisfying the FAR/JAR 25.331 Vertical Design Maneuver Requirements. Attention is given to the possibility that pilot-induced oscillation associated with the sidestick controller will lead to horizontal tailplane overloading, in light of study results which compare conventional and control law-incorporating aircraft which employ sidestick controls. O.C.

A86-38851#

EXPERIMENTAL AEROELASTIC BEHAVIOR OF FORWARD SWEPT GRAPHITE/EPOXY WINGS WITH RIGID BODY FREEDOMS

G.-S. CHEN and J. DUGUNDJI (MIT, Cambridge, MA) IN: Structures, Structural Dynamics and Materials Conference, 27th, San Antonio, TX, May 19-21, 1986, Technical Papers. Part 1 . New York, American Institute of Aeronautics and Astronautics, 1986, p. 462-471. refs

(Contract F49620-85-C-0099)

(AIAA PAPER 86-0971)

An analytical and experimental investigation was made of the aeroelastic flutter and divergence behavior of graphite/epoxy forward swept wings with rigid body pitch and plunge freedoms present. A complete, two-sided 30-degree forward swept wing aircraft model was constructed and mounted with low friction bearings in a low speed wind tunnel. Four different ply layup wings could be interchanged on the model, namely, (0 2/90)s, (15 2/0)s, (30 2/0)s, and (-15 2/0)s. Wind tunnel tests of the 'free' flying models revealed body freedom flutter, bending-torsion flutter, and a support dynamic instability which could be eliminated by proper adjustment of the support stiffness. Good agreement with linear theory was found for all the observed instabilities. Additional tests on the models with rigid body pitch only gave lower critical speeds, while tests on the cantilever wings gave higher speeds. The (15 2/0)s wing gave the best tailored aeroelastic behavior. Author

A86-38861#

A STUDY OF CRACKING IN THE PRESSURE BULKHEAD OF A MILITARY TRANSPORT AIRCRAFT

D. R. SHOWERS, T. F. CHRISTIAN, JR., and D. O. HAMMOND, JR. (USAF, Warner Robins Air Logistics Center, Robins AFB, GA) IN: Structures, Structural Dynamics and Materials Conference, 27th, San Antonio, TX, May 19-21, 1986, Technical Papers. Part 1 . New York, American Institute of Aeronautics and Astronautics, 1986, p. 579-584.

(AIAA PAPER 86-0983)

This paper presents an investigation into aft fuselage pressure bulkhead cracking experience by some U.S. Air Force C-141B military transport aircraft during operational service. Following force wide inspection, an extensive finite element modeling effort was conducted to ascertain the stresses present in the bulkhead which caused the cracking. Following this assessment, an evaluation of potential repairs and modifications was also conducted using finite modeling techniques. This paper points out the fact that detailed studies of fuselage structure now are becoming necessary since military aircraft are remaining in operational inventories longer. This means that the gradual accumulation of pressure cycle damage is now becoming apparent, however, well established analysis techniques which have been used for years to evaluate wing structure are quite adequate for this task. All that is required is that attention be paid to fuselage pressure structure as has been done in the past wing and empennage structure. Author

A86-38865#

GENERIC AIRCRAFT GROUND OPERATION SIMULATION

W. S. PI, J. R. YAMANE, and M. J. C. SMITH (Northrop Corp., Aircraft Div., Hawthorne, CA) IN: Structures, Structural Dynamics and Materials Conference, 27th, San Antonio, TX, May 19-21, 1986, Technical Papers. Part 1 . New York, American Institute of Aeronautics and Astronautics, 1986, p. 606-619. refs

(Contract F33615-82-C-3216)

(AIAA PAPER 86-0989)

A generic aircraft ground operation simulation code was developed under an Air Force contract to provide rapid assessment of the structural capabilities of aircraft under various operating modes and surface conditions. The code is capable of predicting the response of aircraft while performing touchdown, taxiing, turning, and braking operations on paved, paved/bomb-damaged repaired, and unpaved yielding soil-surface runways. Analytical models were established for the airframe structure, the landing gear wheel assembly, and various types of landing gears including the cantilever axle, articulated, and fully levered types. Applying the new simulation code, the predicted ground operation results of C-141B, C-130, F-16, and F-4E aircraft correlated favorably with the test data acquired in the Air Force 'HAVE BOUNCE' program. Author

A86-38869#

A UNIFIED PROCEDURE FOR MEETING POWER-SPECTRAL-DENSITY AND STATISTICAL-DISCRETE-GUST REQUIREMENTS FOR FLIGHT IN TURBULENCE

J. G. JONES (Royal Aircraft Establishment, Farnborough, England) IN: Structures, Structural Dynamics and Materials Conference, 27th, San Antonio, TX, May 19-21, 1986, Technical Papers. Part 1 . New York, American Institute of Aeronautics and Astronautics, 1986, p. 646-652. refs

(AIAA PAPER 86-1011)

The relationship between the power-spectral-density (PSD) and statistical-discrete-gust (SDG) approaches to the analysis and prediction of aircraft response to atmospheric gusts and turbulence is examined in the light of recent studies. In particular, it has been shown that the PSD method can be reformulated and implemented as a variational problem in which the aircraft response is evaluated on the basis of a worst-case analysis to find the associated tuned input pattern, as in the SDG approach. It is thus possible to relate each of the two methods to a common approach in the form of a statistical pattern theory, pointing the way to a possible unified gust specification. V.L.

A86-38893#

REVIEW OF DYNAMIC INFLOW MODELING FOR ROTORCRAFT FLIGHT DYNAMICS

G. H. GAONKAR (Florida Atlantic University, Boca Raton) and D. A. PETERS (Georgia Institute of Technology, Atlanta) IN: Structures, Structural Dynamics and Materials Conference, 27th, San Antonio, TX, May 19-21, 1986, Technical Papers. Part 2 . New York, American Institute of Aeronautics and Astronautics, 1986, p. 89-115. refs

(Contract DAAG29-85-K-0228)

(AIAA PAPER 86-0845)

Dynamic inflow and its influence on some problems of rotorcraft flight dynamics are briefly introduced under transient conditions, as required in flight dynamics. The bases of modeling range from a simple empirical formulation to an involved prescribed-wake, discrete-vortex analysis of a four-bladed rotor. The emphasis is on perturbed linear versions of inflow in matrix form and on the sensitivity of low-frequency stability and response to inflow. However, non-linear versions for use in time-history solutions are presented. Coverage also includes the areas of weakness, controversial notions, and the need for additional test data on rotor-body damping in forward flight for a better appreciation of the developments in modeling dynamic inflow. Author

A86-38902*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

APPLICATION OF THE UNSTEADY VORTEX-LATTICE METHOD TO THE NONLINEAR TWO-DEGREE-OF-FREEDOM AEROELASTIC EQUATIONS

T. W. STRGANAC (NASA, Langley Research Center, Hampton, VA) and D. T. MOOK (Virginia Polytechnic Institute and State University, Blacksburg) IN: Structures, Structural Dynamics and Materials Conference, 27th, San Antonio, TX, May 19-21, 1986, Technical Papers. Part 2 . New York, American Institute of Aeronautics and Astronautics, 1986, p. 201-210. refs

(AIAA PAPER 86-0867)

A means of numerically simulating flutter is established by implementing a predictor-corrector algorithm to solve the equations of motion. Aerodynamic loads are provided by the unsteady vortex lattice method (UVLM). This method is illustrated via the obtainment of stable and unstable responses to initial disturbances in the case of two-degree-of-freedom motion. It was found that for some angles of attack and dynamic pressure, the initial disturbance decays, for others it grows (flutter). When flutter occurs, the solution yields the amplitude and period of the resulting limit cycle. The preliminaray results attest to the feasibility of this method for studying flutter in cases that would be difficult to treat using a classical approach. K.K.

A86-38910#

EFFECTS OF STRUCTURAL NONLINEARITIES ON LIMIT CYCLE RESPONSE OF AERODYNAMIC SURFACES

R. M. LAURENSON, A. J. HAUENSTEIN, J. L. GUBSER (McDonnell Douglas Astronautics Co., St. Louis, MO), and R. P. BRILEY (Harris Corp., Melbourne, FL) IN: Structures, Structural Dynamics and Materials Conference, 27th, San Antonio, TX, May 19-21, 1986, Technical Papers. Part 2 . New York, American Institute of Aeronautics and Astronautics, 1986, p. 279-292. refs

(Contract F49620-82-C-0043; F49620-84-C-0123)

(AIAA PAPER 86-0899)

An asymptotic expansion approximation technique, developed to predict limit cycle oscillation response for aerodynamic surfaces with discrete structural nonlinearities, is presented. To evaluate the adequacy of this technique, numerical simulation results are employed. Several numerical integration techniques are evaluated on a comparative basis for predicting the limit cycle response of the nonlinear system. Results obtained during this study show that: (1) the use of asymptotic expansion methods improves the prediction of aerodynamics surface limit response; (2) the Runge-Kutta, Shanks, and Adams-Moulton simulation techniques are all appropriate for this class of problems; (3) aerodynamic surfaces with structural nonlinearities are susceptible to limit cycle behavior at dynamic pressures below the linear flutter values; (4) the limit cycle respones is characterized as a constant amplitude motion which is a function of the magnitude of the nonlinearity and the dynamic pressure. K.K.

A86-38931#

USE OF THE FLIGHT SIMULATOR IN PERFORMING AFTI/F-16 AIRPLANE AEROSERVOELASTIC ANALYSIS

M. G. ALLEN, M. S. REARDON, and F. W. GORDON (General Dynamics Corp., Fort Worth, TX) IN: Structures, Structural Dynamics and Materials Conference, 27th, San Antonio, TX, May 19-21, 1986, Technical Papers. Part 2 . New York, American Institute of Aeronautics and Astronautics, 1986, p. 493-502. Research supported by General Dynamics Corp. and USAF. refs

(AIAA PAPER 86-0957)

Aeroservoelastic analysis of the AFTI/F-16 airplane for the Automated Maneuvering Attack System Phase has been accomplished by using the dedicated flight simulator. Flexible airframe effects were added, externally generated random noise was applied to a selected control surface loop, and the noise and simulator system response were recorded and monitored with a small independent computer. The response was Fourier transformed, plotted, and margins were obtained. The approach avoided the complexities of mathematically modeling and analyzing non-integer multi-rate digital systems because these systems form a part of the simulator. The approach was possible because digital system technology has provided appropriate computing capacity at reasonable cost. Author

A86-38947#

ACCURATE DYNAMIC THEORY FOR SUPERMANEUVERABLE AIRCRAFT WINGS

G. A. OYIBO (Fairchild Republic Co., Farmingdale, NY) IN: Structures, Structural Dynamics and Materials Conference, 27th, San Antonio, TX, May 19-21, 1986, Technical Papers. Part 2 . New York, American Institute of Aeronautics and Astronautics, 1986, p. 664-671. refs

(Contract F49620-85-C-0090)

(AIAA PAPER 86-1006)

Some dynamic theories that can be used to understand the aeroelastic tailoring mechanism are reviewed. In particular, the accuracy of the St. Venant torsion theory, that is frequently used in aeroelastic analysis, is examined with reference to the effects of the wing aspect ratio and other design parameters. It is shown that ignoring warping arbitrarily using St. Venant's theory can result in errors over 80 percent in analytical results for composite (supermaneuverable) aircraft wings. Accurate modeling of the warping phenomenon is shown to be particularly important for wings with coupling and higher vibration modes. V.L.

A86-38950#

FLUTTER OF WINGS WITH LEADING EDGE CONTROL SURFACES

R. YURKOVICH (McDonnell Aircraft Co., Saint Louis, MO) IN: Structures, Structural Dynamics and Materials Conference, 27th, San Antonio, TX, May 19-21, 1986, Technical Papers. Part 2 . New York, American Institute of Aeronautics and Astronautics, 1986, p. 693-700. refs

(Contract N00019-75-C-0424)

(AIAA PAPER 86-0897)

During the development of the F/A-18 aircraft, aeroelastic analyses were conducted to determine the flutter and divergence characteristics of the aircraft. These analyses indicated that the flutter and divergence speeds of the clean wing are highly dependent on the rotational stiffness of the leading edge flaps. It was found that the leading edge flap divergence is responsible for a body freedom flutter which is similar to that seen with a forward swept wing. Several methods of including the leading edge flaps in the flutter and vibration analyses were investigated. Finally, the analytical results were confirmed by flutter model testing. Author

A86-38952*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

CRASH ENERGY ABSORBING COMPOSITE SUB-FLOOR STRUCTURE

G. L. FARLEY (NASA, Langley Research Center; U.S. Army, Aerostructures Directorate, Hampton, VA) AIAA, ASME, ASCE, and AHS, Structures, Structural Dynamics, and Materials Conference, 27th, San Antonio, TX, May 19-21, 1986. 10 p. refs

(AIAA PAPER 86-0944)

Static crushing tests were conducted on four different beam concepts; honeycomb sandwich, sine-wave and two integrally stiffened designs. The sine-wave beams, depending upon specimen geometry, has the highest energy absorption potential of the four concepts evaluated. All beam designs produced a progressive crushing mode similar to tube specimens. The energy absorption capability of sine-wave beam specimens were predictable from results of circular cross section tubes. A comparison of energy absorption capability was made between integrally stiffened beams fabricated from graphite/epoxy, Kevlar-49/epoxy and aluminum. The energy absorption capability of the graphite/epoxy integrally stiffened beams exceeded both the Kevlar-49/epoxy and aluminum integrally stiffened beams. The energy absorption potential of composite structures is between five and ten times that of comparable metallic structure. Author

A86-39564#
RESEARCH ON THE TECHNOLOGY OF AN AIRPLANE CONCEPT FOR A STATIONARY HIGH-ALTITUDE RELAY PLATFORM (SHARP)
J. DELAURIER, B. GAGNON, J. WONG, R. WILLIAMS, and C. HAYBALL (Toronto, University, Canada) (CASI, Annual General Meeting, 32nd, Montreal, Canada, May 27, 28, 1985) Canadian Aeronautics and Space Journal (ISSN 0008-2821), vol. 32, March 1986, p. 5-22. Research supported by the Canadian Department of Communications. refs

A summary is presented of research carried out by the University of Toronto Institute of Aerospace Studies on an aeronautical Stationary High Altitude Relay Platform (SHARP) for telecommunication relay functions. The design goal is a platform that can fly in stationkeeping mode for up to 1 yr at 21 km altitude. The machine requires an automatic flight controller which can respond to atmospheric disturbances with minimum propulsive energy consumption, besides carrying the microwave relay equipment. Studies thus far, including the construction of prototypes, have identified an aircraft with an oversize stabilizer onto which is mounted a lightweight rectenna. A transmitter on the ground can then beam energy to drive the propeller-driven aircraft, which will also carry the relay equipment. Various design alternatives and techniques explored to lower weight and the required engine power, obtain an aerodynamic configuration suitable for stable flight in climb and loiter, and to define an optimized flight profile are described. Test results with prototype SHARP vehicles are provided and discussed in terms of future research directions. M.S.K.

A86-39565#
LOW AIRSPEED ENVELOPE DETERMINATION OF THE CH-139 JET RANGER HELICOPTER
W. R. JUPP (Department of National Defence, Ottawa, Canada) (CASI, Helicopter Symposium, Montreal, Canada, May 28, 1985) Canadian Aeronautics and Space Journal (ISSN 0008-2821), vol. 32, March 1986, p. 23-33.

The results of engineering trials to determine the low-speed relative-wind limits of the Jet Ranger CH-139 helicopter for training purposes are reported. The low-speed performance was evaluated as a function of the longitudinal center of gravity (CG) and the gross weight (GW), ranging from 107-2300 in. and 2300-2800 lb, respectively. Trials were carried out in hover at wind speeds up to 30 kt. Instrumentation was installed for recording the rotor flap angle, heading, longitudinal and lateral control, fuel consumption and collective position control. The results indicated that the flight envelope is acceptable for training missions. The tests also revealed the worth of monitoring the rotor flapping angle for determining the flight envelope of teetering rotor helicopters. M.S.K.

A86-39597* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
RECENT DEVELOPMENTS IN THE DYNAMICS OF ADVANCED ROTOR SYSTEMS. I
W. JOHNSON (NASA, Ames Research Center, Moffett Field, CA) Vertica (ISSN 0360-5450), vol. 10, no. 1, 1986, p. 73-107. Previously announced in STAR as N85-24320. refs

The problems that were encountered in the dynamics of advanced rotor systems are described. The methods for analyzing these problems are discussed, as are past solutions of the problems. To begin, the basic dynamic problems of rotors are discussed: aeroelastic stability, rotor and airframe loads, and aircraft vibration. Next, advanced topics that are the subject of current research are described: vibration control, dynamic upflow, finite element analyses, and composite materials. Finally, the dynamics of various rotorcraft configurations are considered: hingeless rotors, bearingless rotors, rotors with circulation control, coupled rotor/engine dynamics, articulated rotors, and tilting proprotor aircraft. Author

A86-39763#
SIX-FORCE-FACTOR IDENTIFICATION OF HELICOPTERS
J. ZHANG (Xian Jiaotong University, Xian, People's Republic of China) and W. LI (Flight Test Research Centre of China, People's Republic of China) Acta Aeronautica et Astronautica Sinica, vol. 7, April 1986, p. 139-147. In Chinese, with abstract in English. refs

Applied loads are calculated using motion equations and measured data of the system's motion parameters. The basic theory for a frequency response function method in load identifications is presented, and the use of random loads for load identification is discussed. The three main aspects involved in the six-force-factor identification of helicopters are described in detail. These are: (1) ground calibration, (2) the measurement of structural response in flight, and (3) the calculation of the six-force-factor. It is noted that dynamic load, static load and fatique test data can be obtained simultaneously. It is concluded that the six-force-factor of helicopters was identified successfully, and that the data obtained can be instrumental in helicopter design. K.K.

N86-26320# Aerospace Medical Research Labs., Wright-Patterson AFB, Ohio. Human Engineering Div.
SOME QUANTITATIVE METHODOLOGY FOR COCKPIT DESIGN
C. BATES, JR. and M. M. VIKMANIA *In* AGARD Guidance-Control-Navigation Automation for Night All-Weather Tactical Operations 10 p Oct. 1985 refs
Avail: NTIS HC A07/MF A01

The rapidly developing technology in sensor systems, microprocessors, artificial intelligence and communication systems has blurred the traditional lines between avionics subsystems and offers new design options for integrating the aircrew into the weapon system. These developments, together with the stressful flight regimes imposed by advanced threat systems and the night-in-weather environment required for survival in air-to-ground attack/interdiction, require new approaches to crew station design. These new design opportunities are limited only by the design tools and data bases available for their execution. A simplified cockpit design process can be summarized as conceptual design, detailed design, and design verification. With the many tools needed to pursue this process the subset involving man/machine interface must provide a decision track quantifying and predicting the impact of design decisions on crew performance. To meet the objective of the full utilization of the weapon system crew, each technology option under consideration for incorporation in the cockpit must be judged with consideration of both mission and human performance. The cockpit design process must be embedded in an adequate human performance data base tailored for use by design personnel and must take full advantage of operational experience. The development of a family of cockpit design tools, together with the required data bases, has been one of the objectives of the Air Force Aerospace Medical Research Laboratory research program. From this program a select set of methods will be described and examples provided. Author

N86-26328*# National Aeronautics and Space Administration. Dryden (Hugh L.) Flight Research Center, Edwards, Calif.
X-29A TECHNOLOGY DEMONSTRATOR FLIGHT TEST PROGRAM OVERVIEW
W. J. SEFIC and C. M. MAXWELL May 1986 17 p refs
Presented at the ISA Aerospace Industries/Test Measurement Symposium, Seattle, Wash., 5-8 May 1986
(NASA-TM-86809; H-1347; NAS 1.15:86809; ISA-504) Avail: NTIS HC A02/MF A01 CSCL 01C

An overview of the X-29A functional flight program and concept evaluation program is presented, including some of the unique and different preparations for the first flight. Included are a discussion of the many organizational responsibilities and a description of the program management structure for the test team. Also discussed are preflight ground, flight functional envelope expansion, and flight research test objectives and qualitive results to date for both a limited-envelope flight control system and an expanded-envelope system. The aircraft, including the

instrumentation system and measurements, is described. In addition, a discussion is included regarding the use of major support facilities, such as ground and flight simulators, the NASA Western Aeronautical Test Range and mission control center, and the Grumman automated telemetry station. An overview of the associated real-time and postflight batch data processing software approaches is presented. The use of hardware-in-the-loop simulation for independent verification and validation and mission planning and practice is discussed. Also included is a description of the flight-readiness review, the airworthiness and flight safety review, work scheduling, technical briefings, and preflight and postflight crew briefings. The configuration control process used on the X-29A program is described, and its relationship to both simulation and aircraft operations is discussed. An X-29A schedule overview is presented with an outline of a proposed follow-on program. Author

N86-26329# Federal Aviation Administration, Washington, D.C.
FLIGHT TEST GUIDE FOR CERTIFICATION OF TRANSPORT CATEGORY AIRPLANES
9 Apr. 1986 96 p
(FAA-AC-25-7) Avail: NTIS HC A05/MF A01

These flight test requirement guidelines provide an acceptable means of demonstrating compliance with the applicable airworthiness requirements. Controllability and maneuverability; stability; stalls; ground and water handling characteristics; vibration and buffeting; high speed performance; takeoff and landing; weight and load distribution limits; and propeller speed and pitch limits are discussed. B.G.

N86-26331*# Textron Bell Helicopter, Fort Worth, Tex.
SIX DEGREE-OF-FREEDOM LIVE ISOLATION SYSTEMS, PART 1 Interim Report
D. R. HALWES and C. O. NICKS Apr. 1986 79 p
(Contract NAS1-16969)
(NASA-CR-177928; NAS 1.26:177928) Avail: NTIS HC A05/MF A01 CSCL 01C

A Total Main Rotor Isolation System (TRIS) was analyzed, designed, fabricated, and bench tested for the reduction of main rotor vibration levels transmitted to the helicopter fuselage. The TRIS consists of a six degree-of-freedom passive system using six Liquid Inertia Vibration Eliminator (LIVE) units developed by Bell Helicopter Textron. The objective of the program is to develop a helicopter isolation system that will achieve 90% (or greater) isolation at minimum weight with no degradation in vehicle stability, handling qualities, alignment tolerance, and reliability or maintainability. Author

N86-26332# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
AIRCRAFT NUCLEAR SURVIVABILITY METHODS Ph.D. Thesis
H. A. UNDEM Sep. 1985 279 p
(AD-A163218; AFIT/DS/PH/84-3) Avail: NTIS HC A13/MF A01 CSCL 18C

A new approach for assessing the survivability of aircraft components in nuclear blast and thermal environments is presented in this dissertation. A nonparametric technique is developed for use in calculating the reliability interference integral. This approach eliminates the need for density function identification and parameter estimation. Furthermore, the method can be used without resorting to large-sample random Monte Carlo simulation or propagation of moments. In addition to this, the derived cumulative distribution function using such a technique exactly interpolates the true distribution function at selected points. The method is applied to the problem of aircraft survivability in nuclear blast environments using failure (strength) distributions found in the literature. It is also applied to the case of aircraft survivability in nuclear thermal environments where direct failure data is not available. Inputs to the engineering models involved are treated statistically and the method is used to rigorously determine the statistical nature of the output variables. GRA

N86-26334# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
AIRCRAFT PERFORMANCE OPTIMIZATION WITH THRUST VECTOR CONTROL M.S. Thesis
M. S. FELLOWS Dec. 1985 132 p
(AD-A165388; AFIT/GAE/AA/85D-6) Avail: NTIS HC A07/MF A01 CSCL 01B

The objective of this thesis is to determine to what extent a highly-maneuverable aircraft's overall performance capability is enhanced by thrust-vectoring nozzles. The resulting performance capabilities are compared to a baseline configuration with non-thrust-vectoring nozzles to determine the effects and advantages of thrust vectoring. The results indicate that the use of vectored thrust can significantly increase an aircraft's performance capability in turning flight. The greater the demand on the aircraft in a turning combat scenario, the more the aircraft utilizes its thrust-vectoring capability to complete the task. The results also indicate that the use of vectored thrust in other phases of flight -- such as cruise, acceleration and climb -- only slightly increases an aircraft's performance capability. GRA

N86-27277# National Aerospace Lab., Tokyo (Japan).
AN ANALYSIS OF THE LIMIT CYCLE OBSERVED IN THE FUNCTIONAL MOCKUP TEST OF THE NAL QSTOL RESEARCH AIRCRAFT
H. YAMATO, T. UCHIDA, N. OKADA, T. OGAWA, and A. TADA Dec. 1985 56 p In JAPANESE; ENGLISH summary
(NAL-TR-893; ISSN-0389-4010) Avail: NTIS HC A04/MF A01

The quiet STOL research aircraft under development at the National Aerospace Laboratory is equipped with the Stability and Control Augmentation System (SCAS). When the SCAS Pitch CWS mode is engaged in flight simulation tests using the control system functional mockup, a small limit cycle is observed. The method of describing functions is used to analyze this problem, because nonlinearities in the mechanical linkages and the power actuator play an important role in sustaining the limit cycle. To construct a mathematical model of the control system, nonlinear elements are employed so that the model response may accord with functional mockup test results including the frequency response. Through both the test and the analysis, it is shown that the present method is an effective tool for analyzing the limit cycle. And it is also clarified that the limit cycle observed is not so annoying to the pilot and is within the limits of the MIL specifications for sustained oscillations. Author

N86-27278*# PRC Kentron, Inc., Hampton, Va.
EFFECT OF EMERGING TECHNOLOGY ON A CONVERTIBLE, BUSINESS/INTERCEPTOR, SUPERSONIC-CRUISE JET
F. L. BEISSNER, JR., W. A. LOVELL, A. W. ROBINS, and E. E. SWANSON May 1986 60 p
(Contract NAS1-18000)
(NASA-CR-178097; NAS 1.26:178097) Avail: NTIS HC A04/MF A01 CSCL 01C

This study was initiated to assess the feasibility of an eight-passenger, supersonic-cruise long range business jet aircraft that could be converted into a military missile carrying interceptor. The baseline passenger version has a flight crew of two with cabin space for four rows of two passenger seats plus baggage and lavatory room in the aft cabin. The ramp weight is 61,600 pounds with an internal fuel capacity of 30,904 pounds. Utilizing an improved version of a current technology low-bypass ratio turbofan engine, range is 3,622 nautical miles at Mach 2.0 cruise and standard day operating conditions. Balanced field takeoff distance is 6,600 feet and landing distance is 5,170 feet at 44,737 pounds. The passenger section from aft of the flight crew station to the aft pressure bulkhead in the cabin was modified for the interceptor version. Bomb bay type doors were added and volume is sufficient for four advanced air-to-air missiles mounted on a rotary launcher. Missile volume was based on a Phoenix type missile with a weight of 910 pounds per missile for a total payload weight of 3,640 pounds. Structural and equipment weights were adjusted and result in a ramp weight of 63,246 pounds with a fuel load of 30,938 pounds. Based on a typical intercept mission flight

profile, the resulting radius is 1,609 nautical miles at a cruise Mach number of 2.0. Author

N86-27279*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
DIVERGENCE STUDY OF A HIGH-ASPECT RATIO, FORWARD-SWEPT WING
S. R. COLE Jun. 1986 10 p Presented at the AIAA 24th Aerospace Sciences Meeting, Reno, Nev., 6-9 Jan. 1986 Previously announced in IAA as A86-19632
(NASA-TM-87682; NAS 1.26:87682) Avail: NTIS HC A02/MF A01 CSCL 01C

An experimental wind-tunnel study to determine the divergence characteristics of a high-aspect ratio, forward-swept wing has been conducted in the NASA Langley Research Center (LaRC) Transonic Dynamics Tunnel (TDT). The rectangular wing used for this study had a panel aspect ratio of 9.16 (lambda = 0 deg.) and the sweep angle could be set at lambda = 0 deg., -15 deg., -30 deg., -45 deg., or -60 deg. A rectangular wing tip shape was tested at each of these sweep angles. In addition, a tip shape parallel to the freestream flow was tested for a wing sweep angle of lambda = -45 deg. The root of the wing was cantilever mounted to the wall of the wind tunnel. Divergence conditions were measured at M = 0.4 for each sweep angle and tip configuration tested. Subcritical response techniques were used to extrapolate to the divergence conditions during the wind-tunnel test. The primary objective of this test was to obtain data which could be used to verify for this configuration the divergence prediction capability of an aeroelastic analysis code. Subsonic lifting surface theory (kernel function) aerodynamics are utilized by this particular code. The analytical predictions of divergence were found to be significantly conservative at all forward sweep angles. At lambda = -45 deg., the analysis was 14 percent conservative. The effect of the two tip shapes on the divergence dynamic pressure was predicted accurately by the analysis. The divergence condition for the tip shape parallel to the flow occurred at a dynamic pressure 14 percent higher than the divergence condition with a rectangular tip shape. Author

06

AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

A86-37193
PUTTING HUMANS INTO VIRTUAL SPACE
T. A. FURNESS, III and D. F. KOCIAN (USAF, Armstrong Aerospace Medical Research Laboratory, Wright-Patterson AFB, OH) IN: Aerospace simulation II; Proceedings of the Second Conference, San Diego, CA, January 23-25, 1986 . San Diego, CA, Society for Computer Simulation, 1986, p. 214-230. refs

Existing computer displays fail to communicate effectively spatial information to humans in a number of piloting, command, control, communication and design applications. These interfaces are further limited by unnatural operator input modes. To solve these problems the concept of a virtual crew station is introduced which is implemented by visual and auditory virtual displays and natural psychomotor controls including voice, head, eye and hand controllers. A virtual space simulator called the Visually-Coupled Airborne Systems Simulator (VCASS) is described. Experimental findings using the VCASS are related, demonstrating the utility, performance and areas of improvement needed for virtual interfaces. Future applications of a virtual terminal are also discussed. Author

A86-37333
A THERMAL IMAGING PAYLOAD FOR RPV APPLICATIONS
W. T. MOORE and T. D. WOOLLS (Rank Pullin Controls, Ltd., Leicester, England) IN: Remotely piloted vehicles; International Conference, 5th, Bristol, England, September 9-11, 1985, Proceedings . Bristol, England, University of Bristol, 1985, p. 14.1-14.10. Research supported by the Royal Signals and Radar Establishment.

Attention is given to the design process considerations, adopted features, and prospective performance of an RPV-carried thermal IR imaging payload. The present design employs coaxial polygon optics, whose scan mechanism, corresponding to a 7-cm cube, can provide high performance with 448 lines. Attention is given to such system features as the automation of imager controls, the cryogenic cooling system, the wide angle telescope, and the video channel downlink to a ground station. O.C.

A86-37341
THERMAL ZOOM OPTICS FOR R.P.V. SENSORS
M. ROBERTS (Pilkington P.E., Ltd., St. Asaph, Wales) IN: Remotely piloted vehicles; International Conference, 5th, Bristol, England, September 9-11, 1985, Supplementary Papers . Bristol, England, University of Bristol, 1985, p. 15.1-15.8. refs

The 8-13 micron thermal IR band offers the advantages of both day and night use; attention is presently given to an IR zoom lens system applicable to RPV sensor payloads in virtue of its compactness. The optical system comprises an IR scanner and afocal telescope optics, by which collimated thermal radiation from the scene is collected by the objective and focused at an intermediate point, from which it is in turn recollimated into the scanner pupil. Switchable optics, optically and mechanically compensated zoom optics, mechanical design, and testing considerations are discussed. O.C.

A86-37342
THE PHOENIX SENSOR TURRET SYSTEM
A. J. MCQUIGGAN (GEC Avionics, Ltd., Electro Optical Surveillance Div., Basildon, England) IN: Remotely piloted vehicles; International Conference, 5th, Bristol, England, September 9-11, 1985, Supplementary Papers . Bristol, England, University of Bristol, 1985, p. 16.1-16.8.

The Phoenix sensor turret system's design features and operational capabilities are discussed. The Phoenix turreted, stabilized thermal imaging sensor comprises an imager, cryogenic cooling, and processing and stabilization electronics, integrated into a single LRU. This modular design has yielded a survivable and easily maintainable system whose versatility extends to the incorporation of alternative sensors; it is also applicable to RPVs other than Phoenix. Attention is given to the sensor telescope and cryogenic cooling system. O.C.

A86-37343
APPLICATIONS OF SENSOR PAYLOADS
J. W. JACK (Ferranti Defence Systems, Ltd., Electro-Optics Dept., Edinburgh, Scotland) IN: Remotely piloted vehicles; International Conference, 5th, Bristol, England, September 9-11, 1985, Supplementary Papers . Bristol, England, University of Bristol, 1985, p. 17.1-17.7.

An account is given of the availability and performance capabilities of TV, intensified TV, pyroelectric vidicon, and thermal imaging systems applicable to visible to far-IR sensing tasks aboard RPV platforms. Attention is given to a number of payload configurations which, while conceived to meet a military requirement for the detection and recognition of a military vehicle, are not restricted to military applications. Civilian applications include thermal emission surveys for local governments and industrial concerns, traffic flow pattern surveillance, and pipeline and transmission line surveys. O.C.

A86-38322
INSTALLATION OF A BLEED AIR HEATED RADOME/AIR MOTION SENSING SYSTEM ON A BEECH KING AIR 200 AIRCRAFT
M. N. ZRUBEK (National Center for Atmospheric Research, Boulder, CO) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 7 p.
(SAE PAPER 851811)
The Research Aviation Facility (RAF) of the National Center for Atmospheric Research (NCAR) has developed a nose mounted differential pressure air motion sensing system for a Beech King Air 200 aircraft that allows air motion sensing (small scale turbulence) in three axes (horizontal, vertical, and longitudinal) to be taken under a variety of atmospheric conditions. This system is incorporated into a custom designed radome which utilizes engine bleed air heat for anti-ice capability and allows the use of the aircraft storm avoidance radar. Author

A86-38324* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
RETROFITTING AVIONICS - CLOSING THE PERFORMANCE 'GENERATION GAP'
C. R. SPITZER (NASA, Langley Research Center, Hampton, VA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 7 p. refs
(SAE PAPER 851813)
The retrofitting of advanced avionics to in-service aircraft in order to increase operational safety and flexibility, and reduce operating costs is analyzed. Research in flight management planning and airborne guidance for full-and cost-effective flight is examined. The use of CRTs and thin film electroluminescent displays in aircraft is described. The development of more accurate and reliable fuel gauges using nuclear-based techniques or volumetric measurements to evaluate fluid levels is studied. Advances in airspace systems, such as the Microwave Landing System, and Air Traffic Control Beacon System/Select Mode, the Traffic Advisory and Collision Advance System, and satellite-based communications, navigation, and surveillance are discussed. I.F.

A86-38345
THE INTEGRATED DIGITAL AVIONICS SYSTEM FOR THE F-20 TIGERSHARK
W. L. SMITH (Northrop Corp., Aircraft Div., Hawthorne, CA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 16 p.
(SAE PAPER 851850)
Salient features of the avionics system to be discussed include: (1) a federated arrangement of the multiple processors in the system that maximizes mission reliability, (2) integration of the system using a MIL-STD-1553 multiplex data bus that minimizes the effects of changes and growth, and (3) a pilot-friendly cockpit using one head-up and two head-down displays and controls that allow combat with hands on stick and throttle. Author

A86-38346
AVIONICS SYSTEM ARCHITECTURE FOR BEECHCRAFT STARSHIP 1
C. A. FENWICK and J. L. SPENCER (Rockwell International Corp., Avionics Group, Cedar Rapids, IA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 19 p.
(SAE PAPER 851851)
The architectural design of avionics to be used in the Beechcraft Starship 1 aircraft is presented. The avionics system consists of an integrated array of over 70 electronic line replaceable units organized to provide unprecedented levels of functional capability, fault tolerance, and reconfigurability. The digital data communication network connects all avionics and many nonavionics systems, including engine and fuel sensors, through the use of a dual-dual set of data concentrators. As compared with the current avionics equipment, the advanced avionics concept will result in weight and volume reductions, fewer wires and an integrated data network, simplified cockpit operation, and enhanced reliability. I.S.

N86-26321# Thomson-CSF, Issy les Moulineaux (France).
SYNTHETIC REAL-TIME RELIEF DISPLAY ALL-WEATHER AIRBORNE MISSIONS
J. N. BOTELLA *In* AGARD Guidance-Control-Navigation Automation for Night All-Weather Tactical Operations 4 p Oct. 1985
Avail: NTIS HC A07/MF A01
Within the context of all-weather airborne missions, it is necessary to provide the pilot with information on the external world, even, and particularly when information provided by radar or optronic sensors are failing. The development of altimetric digital data banks prompts investigations to examine the display of synthetic relief in a cockpit. The study of various mass storages shows that a color film has remarkable storage capacities. Altimetric data are stored on a film read by the MERCATOR reader (whose initial function is to read map images). Three-dimensional synthesis algorithms are used and they are provided with the exceptional possibilities enabled by the MERCATOR analysis. The philosophy of this study is to show how a unique product, the map reader MERCATOR, designed to display plane images, is used to perform tridimensional displays of relief. Author

N86-26322# Farrand Optical Co., Inc., Valhalla, N.Y.
THE WIDE FIELD HELMET MOUNTED DISPLAY
J. LARUSSA *In* AGARD Guidance-Control-Navigation Automation for Night All-Weather Tactical Operations 7 p Oct. 1985 refs
Avail: NTIS HC A07/MF A01
The wide field helmet mounted display developed by the Farrand Optical Company, Inc. is described. This display provides the pilot with an instantaneous field of view of 60 deg vertically and 135 deg horizontally. The central field of view consists of an overlap field of 25 deg within which full stereopsis is available. It would appear that a new design which the Farrand Optical Company, Inc. is now in the process of designing for Aerospace Medical Research Laboratory (AMRK) would be applicable for night all weather operations where such data as flight path control, computed weapon projectories, synthetic outside world views, expected and unexpected threats and automatic terrain following paths would be displayed. The parameters that must be considered in designing a wide field helmet mounted display are discussed. Briefly, these parameters are size, weight and balance on the head, brightness of the display and see-through ability of the display. The discussion assumes the use of a one inch, high brightness, high resolution CRT input already developed and operational. Author

N86-26323# Marconi Avionics Ltd., Rochester (England). Aircraft and Missile Systems.
A SOLID-STATE MAP DISPLAY FOR RAPID RESPONSE OPERATION
D. J. POWELL and T. E. CRAYFORD *In* AGARD Guidance-Control-Navigation Automation for Night All-Weather Tactical Operations 13 p Oct. 1985
Avail: NTIS HC A07/MF A01
A means to provide pilots with a presentation of a moving color map display on a standard color CRT is described. It uses solid-state techniques and derives the display from a digital database. The design criteria used in the development of the system are discussed and an overview of the system operation is presented. Finally, one of the many ways in which the system as a whole may be used in operation is addressed. Author

N86-26335# National Aerospace Lab., Amsterdam (Netherlands). Flight Div.
METHOD FOR DETERMINING THE TIME DELAY OF THE PITOT-STATIC TUBING SYSTEM OF AIRCRAFT
J. H. BREEMAN 17 Jun. 1985 19 p
(NLR-TR-83075-U; ESA-86-96978) Avail: NTIS HC A02/MF A01
The measurement of the response of the pitot-static tubing system of aircraft is described. A small jet transport is used as an example. Results of measurements performed on the ground and at an altitude of 3000 ft are reported. ESA

N86-27280* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
AIRCRAFT LIFTMETER Patent
E. W. MILLEN, inventor (to NASA) 29 Apr. 1986 10 p Filed 8 Feb. 1984 Supersedes N84-32383 (22 - 22, p 3535) Sponsored by NASA. Langley Research Center
(NASA-CASE-LAR-12518-1; US-PATENT-4,586,140; US-PATENT-APPL-SN-578388; US-PATENT-CLASS-364-433; US-PATENT-CLASS-364-435; US-PATENT-CLASS-244-181; US-PATENT-CLASS-73-178T; US-PATENT-CLASS-340-968)
Avail: US Patent and Trademark Office CSCL 01D

A display for aiding the pilot of an aircraft in anomalous wind environments is described. Wind velocity components are measured by an instrument, processed by a computer and a vector generator, and then displayed as a vector. The display utilizes the measurements of ground speed and of wind velocity in three mutually perpendicular directions. This display will also show changes in lift of an aircraft. B.W.

07

AIRCRAFT PROPULSION AND POWER

Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and on-board auxiliary power plants for aircraft.

A86-37331
P T A - DESIGN CONSIDERATIONS FOR AN AIRFRAME SYSTEM AND DETAILED DESIGN OF FUEL SUBSYSTEM
P. SINGH, R. VENKATESH, and A. R. ACHYUTHA RAO (Aeronautical Development Establishment, Bangalore, India) IN: Remotely piloted vehicles; International Conference, 5th, Bristol, England, September 9-11, 1985, Proceedings . Bristol, England, University of Bristol, 1985, p. 12.1-12.15. refs

Pilotless Target Aircraft (PTAs) are turbojet-propelled, high subsonic cruise RPVs that can be used in several consecutive sorties for weapons development and fighter pilot training. Attention is presently given to the design features and performance characteristics of a PTA's fuel subsystems, which employ engine bleed air for pressurization. A detailed anticipation has been made of center-of-gravity shifts under various operational conditions, as well as of fuel system compressor bleed capacities for pressurization over the range of PTA engine rpm values. O.C.

A86-37344
'A FLYWHEEL POWERED RPV LAUNCHER - PUTTING THEORY INTO PRACTICE'
D. GRIFFIN (Frazer-Nash, Ltd., Kensington-upon-Thames, England) IN: Remotely piloted vehicles; International Conference, 5th, Bristol, England, September 9-11, 1985, Supplementary Papers . Bristol, England, University of Bristol, 1985, p. 23.1-23.9. Research supported by the Ministry of Defence (Procurement Executive).

The present RPV launching system employs an electric motor-accelerated flywheel to store energy, which is then extracted in the form of nearly steady torque by electromagnetic slipping clutches. This torque is applied via high speed capstan and steel cable to a sliding beam which, in turn, carries a trolley with RPV attachment points. The launcher is transported aboard a Land Rover and operates in all weather conditions without smoke or vapor signatures; launch velocity and peak acceleration are adjustable for a range of RPV weights. O.C.

A86-37345
A SPRING IN THE AIR
T. C. NOTTINGHAM (Admiralty Research Establishment, Portsdown, England) IN: Remotely piloted vehicles; International Conference, 5th, Bristol, England, September 9-11, 1985, Supplementary Papers . Bristol, England, University of Bristol, 1985, p. 24.1-24.7.

Design considerations and a development history are presented for an inexpensive, low technology, spring-based RPV launch system. The choice of a spring was based on the linearity of its response, as well as its excellent fatigue life and imperviousness to atmospheric and temperature conditions. The launcher configuration uses the spring in compression in order to minimize hazards to operators in the event of linkage failure. O.C.

A86-37827*# Nielsen Engineering and Research, Inc., Mountain View, Calif.
UNSTEADY FORCES ON COUNTER-ROTATING PROPELLER BLADES
D. J. LESIEUTRE (Nielsen Engineering and Research, Inc., Mountain View, CA) and J. P. SULLIVAN (Purdue University, West Lafayette, IN) IN: Applied Aerodynamics Conference, 4th, San Diego, CA, June 9-11, 1986, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1986, p. 229-236. refs
(Contract NSG-3135)
(AIAA PAPER 86-1804)

Unsteady forces experienced by counter-rotating propeller blades are examined in this paper. A fully coupled vortex lattice model of counter-rotation is used to obtain a quasi-steady solution to the propeller loadings, and an unsteady Sears (1941) analysis provides an estimate of the unsteady loads from the quasi-steady results. The vortex lattice method predicts the overall performance of counter-rotation well, based on comparisons of measured and predicted results. The effects of propeller spacing and blade number on the unsteady loadings are investigated. The peak-to-peak variation about the mean of the unsteady loads on the rear propeller varied from 9 percent for a 2 x 2 counter-rotation system to 2 percent for an 8 x 8 system. Author

A86-38334
RELIABILITY AND MAINTAINABILITY - A LOOK AT THE ROLLS-ROYCE RB.211
R. G. JACKSON (Rolls-Royce, Inc., Greenwich, CT) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 7 p.
(SAE PAPER 851829)

This paper addresses the Reliability and Maintainability aspects of the Rolls-Royce RB.211 high by-pass engine, which entered airline service more than 13 years ago. Improvements in Reliability, a new approach to engine management, both in-shop and on-wing, and the importance of Maintainability features are discussed. Reference is also included to performance retention over extended calendar periods, and the eventual achievement of extremely high rates of Reliability, as the various lessons learned over the years are applied to derivative engine models. Author

A86-38892*# Purdue Univ., West Lafayette, Ind.
PASSIVE CONTROL OF AERODYNAMICALLY FORCED VIBRATIONS OF SUPERSONIC TURBOMACHINE ROTORS BY SPLITTER BLADES
S. FLEETER, D. A. TOPP (Purdue University, West Lafayette, IN), and D. HOYNIAK (NASA, Lewis Research Center, Cleveland, OH) IN: Structures, Structural Dynamics and Materials Conference, 27th, San Antonio, TX, May 19-21, 1986, Technical Papers. Part 2 . New York, American Institute of Aeronautics and Astronautics, 1986, p. 77-88. NASA-supported research. refs
(AIAA PAPER 86-0844)

An aeroelastic model is developed to examine the use of splitter blades as a passive detuning mechanism for flow induced forced response of unstalled supersonic turbomachine rotors. The splitters introduce aerodynamic and structural detuning to the rotor design. The relationship between aerodynamic and structural detuning and

the location and chord lengths of splitters is analyzed. The model is applied to the flow induced response of four 12-blade rotors with Verdon's (1973) Cascade B flow geometry. The data reveal that for gusts characterized by forward and backward traveling waves the splitters generally decrease the maximum amplitudes of response; however, for some gust load interblade phase angles, such as -180 deg and 120 deg the splitters did not reduce the amplitudes of response. I.F.

A86-38894*# Purdue Univ., West Lafayette, Ind.
THREE DIMENSIONAL UNSTEADY AERODYNAMICS AND AEROELASTIC RESPONSE OF ADVANCED TURBOPROPS
M. H. WILLIAMS and C.-C. HWANG (Purdue University, West Lafayette, IN) IN: Structures, Structural Dynamics and Materials Conference, 27th, San Antonio, TX, May 19-21, 1986, Technical Papers. Part 2 . New York, American Institute of Aeronautics and Astronautics, 1986, p. 116-124. refs
(Contract NAG3-499)
(AIAA PAPER 86-0846)

A method for the prediction of steady and unsteady aerodynamic loads and aeroelastic response of advanced turboprops is presented. The aerodynamic analysis uses three dimensional unsteady linearized compressible flow theory to compute the blade pressure distribution. The aeroelastic analysis is based on a normal mode representation of the structure. The method is applicable to both conventional and advanced turbo-prop configurations, provided that blade stall and transonic shock waves are not important factors. Aerodynamic results are presented which validate the model in various limits by comparisons to alternative theories and experimental data. Finally, results of a stability analysis of an advanced turboprop are given, with comparisons to measurements made at NASA Lewis Research Center. Author

A86-38927#
DURABILITY PREDICTION OF PARALLEL FUEL TANK SKINS WITH FLUID-STRUCTURE INTERACTION DYNAMICS
M. A. FERMAN, M. D. HEALEY, W. H. UNGER (McDonnell Aircraft Co., Saint Louis, MO), and M. D. RICHARDSON (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) IN: Structures, Structural Dynamics and Materials Conference, 27th, San Antonio, TX, May 19-21, 1986, Technical Papers. Part 2 . New York, American Institute of Aeronautics and Astronautics, 1986, p. 456-463. refs
(AIAA PAPER 86-0935)

Premature fatigue of parallel fuel tank skins due to fluid-structure interaction loading is addressed and is believed to explain some of the widespread leakage of military aircraft. Earlier effort with a single flat panel was extended to parallel panels configured as sides or top/bottom combinations. This expansion of the concept brings it one step closer to a general method where the in-flight and general vibration environments producing this effect can be included along with the maneuver spectrum loading in design and application. A combined analytical and experimental approach was used. Author

A86-38949#
AEROELASTIC TAILORING OF ADVANCED COMPOSITE COMPRESSOR BLADES
O. O. BENDIKSEN and J. F. WHITE, III (Princeton University, NJ) IN: Structures, Structural Dynamics and Materials Conference, 27th, San Antonio, TX, May 19-21, 1986, Technical Papers. Part 2 . New York, American Institute of Aeronautics and Astronautics, 1986, p. 684-692. refs
(AIAA PAPER 86-1008)

An analytical investigation of aeroelastic tailoring concepts for compressor blades is presented. The study is based on a Rayleigh-Ritz formulation with five elastic degrees-of-freedom per blade, including a plate-type mode to account for chordwise bending. A linearized two-dimensional supersonic cascade theory is used to calculate the unsteady aerodynamic forces. The chordwise mode is highly unstable for low aspect ratio composite blades with little or no sweep of the laminate fibers. A moderate aft fiber sweep produces bending-torsion coupling which is stabilizing on the first torsion branch, but which is destabilizing on the first bending branch. Forward fiber sweep is generally destabilizing except on the chordwise branch. By using a crossed-ply laminate configuration, a highly unstable blade section is successfully stabilized up to a Mach number of 1.55. The corresponding titanium blade is unstable for all supersonic Mach numbers. Author

A86-38956
OFF-DESIGN OPERATION OF TURBOMACHINES [FONCTIONNEMENT HORS ADAPTATION DES TURBOMACHINES]
V. BENSIMHON (SNECMA; Ecole Nationale Superieure de l'Aeronautique, Paris; Ecole Speciale des Travaux Aeronautiques, Orsay, France) Paris, Masson, 1986, 175 p. In French.

The importance of geometry in the calculation of engine off-design operation and on the various independent parameters determining engine performance is considered in addition to the impact of flight condition or geometry change on performance. A study of engine components is followed by an examination of the advantages and disadvantages of various turbomachines, both in terms of performance and aircraft integration. Aerodynamic, thermal, and mechanical engine component limits are considered in the physical construction of turbomachines such as the single-spool turbojet, double-spool turbojet, double-spool turbofan, and the turbofan. R.R.

A86-38994#
A MATHEMATICAL MODEL FOR CALCULATION OF EFFECTS OF AIR HUMIDITY FUEL COMPOSITION AND GAS DISSOCIATION ON ENGINE PERFORMANCE AND ITS ACTUAL APPLICATION
Y. GU (Nanhua Powerplant Research Institute, Zhuzhou, People's Republic of China) Journal of Engineering Thermophysics, vol. 7, Feb. 1986, p. 51-55. In Chinese, with abstract in English.

A86-38998#
TEMPERATURE DISTRIBUTION INVESTIGATION AT THE OUTLET OF AN ANNULAR COMBUSTOR OF P TYPE TURBOJET ENGINE
B. ZHANG (Shenyang Aeronautics Institute, People's Republic of China) Journal of Engineering Thermophysics, vol. 7, Feb. 1986, p. 78-80. In Chinese, with abstract in English.

Some problems of temperature distribution at the outlet of an annular combustor of a P type turbojet engine are described. The change law of maximum temperature, thermal zones, and the stability in the temperature field are demonstrated. The appropriate radial temperature distribution can be obtained by adjusting the mass flow ratio through the inner and outer annular ducts within the range of 0.94-0.98. The effects of supports, tubes, and ignitors on the temperature distribution of the annular combustor are less than that of a can-ring. Author

A86-39079#
IDENTIFICATION OF LONGITUDINAL ACOUSTIC MODES ASSOCIATED WITH PRESSURE OSCILLATIONS IN RAMJETS
W. H. CLARK (U.S. Navy, Naval Weapons Center, China Lake, CA) and J. W. HUMPHREY Journal of Propulsion and Power (ISSN 0748-4658), vol. 2, May-June 1986, p. 199-205. Previously cited in issue 16, p. 2286, Accession no. A84-35665. refs

A86-39086#
SURFACE LAYER ACTIVATION TECHNIQUE FOR MONITORING AND IN SITU WEAR MEARUREMENT OF TURBINE COMPONENTS
C. C. BLATCHLEY and P. SIOSHANSI (Spire Corp., Bedford, MA) Journal of Propulsion and Power (ISSN 0748-4658), vol. 2, May-June 1986, p. 248-252. Previously cited in issue 17, p. 2434, Accession no. A84-37652. refs

A86-39568#
SURGE MARGIN ENHANCEMENT BY A POROUS THROAT DIFFUSER
J. A. RAW (Pratt and Whitney Canada, Inc., Longueil) (CASI, Annual General Meeting, 32nd, Montreal, Canada, May 27, 28, 1985) Canadian Aeronautics and Space Journal (ISSN 0008-2821), vol. 32, March 1986, p. 54-60.

An aerodynamic fix has been devised for the diffuser of a centrifugal compressor to increase the stalling range of the diffuser significantly. The advent of lightweight composite helicopter rotors has reduced the inertia of rotor blades, creating a situation where the rotors can rapidly lose speed. The helicopter engines must therefore be able to accelerate quickly to prevent 'droop' from occurring. The acceleration must be from zero to maximum power in 2 sec, twice as fast as the previous top performance. Previous tests had shown that the surge margin in a compressor diffuser (CD) could be expanded by making the CD walls porous, thereby linking the diffuser throats by a communication manifold, equalizing pressures in the throats and making all diffuser blades reach stall at the same time instead of some before others. The gain in surge margin is sufficient to meet the new acceleration demands at a cost of only one percent of efficiency. The concept is in trials in the PT6 B-36 engine on a Sikorsky S-76 helicopter. Early test results have confirmed the enhanced transient engine response at a negligible efficiency loss. M.S.K.

A86-39725#
GAS AND EROSION CORROSION OF THE COMBUSTION CHAMBERS OF AIRCRAFT ENGINES [GAZOWA I EROZYJNA KOROZJA KOMOR SPALANIA SILNIKOW LOTNICZYCH]
L. DROZDZ and R. GRUCHALSKI (WSK PZL, Rzeszow, Poland) Technika Lotnicza i Astronautyczna (ISSN 0040-1145), vol. 40, Nov.-Dec. 1985, p. 6, 7. In Polish.

The mechanisms of the gas and erosion corrosion of the turbine blades and combustion chambers of aircraft engines are examined. In particular, attention is given to the effect of vanadium, molybdenum, and sulfur contents in the combustion products on the corrosion of turbine blades of Cr-Ni steels of various compositions; the effect of sulfur on gas corrosion of Cr-Ni steels is shown to be particularly strong. Experimental data on the erosion corrosion of a combustion chamber of EI435 alloy are reported, and photographs of areas damaged by erosion corrosion are presented. V.L.

N86-26338# Aeronautical Research Labs., Melbourne (Australia).
THE GENERAL ELECTRIC F404 - ENGINE OF THE RAAF'S NEW FIGHTER
D. FRITH Jul. 1985 55 p refs
(AD-A164562; ARL-AERO-PROP-TM-426) Avail: NTIS HC A04/MF A01 CSCL 21E

The F404 engine in the F/A-18 is representative of a new generation of military turbofan engines. The features of the engine that govern its performance and contribute to its maintainability are discussed. The intention is to give the non-specialist an appreciation of those factors materially affecting the operation of this type of engine. The RAAF F/A-18 Hornets are powered by two General Electric F404-GE-400 augmented turbofan engines. The 3-stage fan, driven by the low-pressure turbine, compresses inlet air that subsequently divides into the bypass and core flows. Variable inlet guide vanes schedule the direction of the flow into the fan as a function of rotational speed. The core flow is further compressed for entry to the annular combustor by the compressor, driven by the high-pressure turbine. Variable inlet guide and two rows of stators adjust the flow direction as a function of corrected compressor speed. After expansion through the turbines, the high temperature gas from the combustion process is mixed with the bypass air to form the high speed jet out of the exhaust nozzle. When operating in afterburning mode, the speed of this jet is increased by additional combustion in the afterburner. GRA

N86-27282*# Hamilton Standard, Windsor Locks, Conn.
LARGE-SCALE ADVANCED PROP-FAN (LAP) PITCH CHANGE ACTUATOR AND CONTROL DESIGN REPORT
R. A. SCHWARTZ, P. CARVALHO, and M. J. CUTLER 31 Jan. 1986 187 p Original document contains color illustrations
(Contract NAS3-23051)
(NASA-CR-174788; NAS 1.26:174788) Avail: NTIS HC A09/MF A01 CSCL 01A

In recent years, considerable attention has been directed toward improving aircraft fuel consumption. Studies have shown that the high inherent efficiency previously demonstrated by low speed turboprop propulsion systems may now be extended to today's higher speed aircraft if advanced high-speed propeller blades having thin airfoils and aerodynamic sweep are utilized. Hamilton Standard has designed a 9-foot diameter single-rotation Large-Scale Advanced Prop-Fan (LAP) which will be tested on a static test stand, in a high speed wind tunnel and on a research aircraft. The major objective of this testing is to establish the structural integrity of large-scale Prop-Fans of advanced construction in addition to the evaluation of aerodynamic performance and aeroacoustic design. This report describes the operation, design features and actual hardware of the (LAP) Prop-Fan pitch control system. The pitch control system which controls blade angle and propeller speed consists of two separate assemblies. The first is the control unit which provides the hydraulic supply, speed governing and feather function for the system. The second unit is the hydro-mechanical pitch change actuator which directly changes blade angle (pitch) as scheduled by the control. Author

N86-27283*# Pratt and Whitney Aircraft, East Hartford, Conn. Commercial Products Div.
STRUCTURAL TAILORING OF ENGINE BLADES (STAEBL) THEORETICAL MANUAL
K. W. BROWN Mar. 1985 51 p
(Contract NAS3-22525)
(NASA-CR-175112; NAS 1.26:175112; PWA-5774-40) Avail: NTIS HC A04/MF A01 CSCL 21E

This Theoretical Manual includes the theories included in the Structural Tailoring of Engine Blades (STAEBL) computer program which was developed to perform engine fan and compressor blade numerical optimizations. These blade optimizations seek a minimum weight or cost design that satisfies practical blade design constraints, by controlling one to twenty design variables. The STAEBL constraint analyses include blade stresses, vibratory response, flutter, and foreign object damage. Blade design variables include airfoil thickness at several locations, blade chord, and construction variables: hole size for hollow blades, and composite material layup for composite blades. Author

N86-27284*# Pratt and Whitney Aircraft, East Hartford, Conn. Commercial Products Div.
STRUCTURAL TAILORING OF ENGINE BLADES (STAEBL) USER'S MANUAL
K. W. BROWN Mar. 1985 106 p
(Contract NAS3-22525)
(NASA-CR-175113; NAS 1.26:175113; PWA-5774-39) Avail: NTIS HC A06/MF A01 CSCL 21E

This User's Manual contains instructions and demonstration case to prepare input data, run, and modify the Structural Tailoring of Engine Blades (STAEBL) computer code. STAEBL was developed to perform engine fan and compressor blade numerical optimizations. This blade optimization seeks a minimum weight or cost design that satisfies realistic blade design constraints, by tuning one to twenty design variables. The STAEBL constraint analyses include blade stresses, vibratory response, flutter, and foreign object damage. Blade design variables include airfoil thickness at several locations, blade chord, and construction variables: hole size for hollow blades, and composite material layup for composite blades. Author

08

AIRCRAFT STABILITY AND CONTROL

Includes aircraft handling qualities; piloting; flight controls; and autopilots.

A86-37332

DESIGNING COMPACT ELECTROMECHANICAL ACTUATORS FOR FLIGHT CONTROL

J. MABIE (Kollmorgen Corp., Inland Motor Div., Radford, VA) and G. HORNER (Hightech Components, Ltd., Tadley, England) IN: Remotely piloted vehicles; International Conference, 5th, Bristol, England, September 9-11, 1985, Proceedings . Bristol, England, University of Bristol, 1985, p. 13.1-13.6.

The electromechanical actuator described in this paper was designed to be used for primary flight control of a subsonic target drone. The actuator includes a motor, failsafe brake, gearing, dual feedback potentiometer and electronics all contained within a totally sealed housing. The electronics consist of a position servo amplifier with a Pulse Width Modulated power stage as well as filtering to meet stringent Electromagnetic Interference requirements. This paper describes the design process including design choices, analysis and experimental effort expended to ensure that the actuator would go through the battery of qualification tests with minimal complications. Author

A86-37335

A REAL-TIME SIMULATION OF A NON-LINEAR RPV INCORPORATING HEAD-UP TYPE COLOUR GRAPHICS

P. P. ASLIN, J. V. HATFIELD, R. J. PATTON (York, University, Heslington, England), and A. J. A. OXTOBY (Hull, University, England) IN: Remotely piloted vehicles; International Conference, 5th, Bristol, England, September 9-11, 1985, Proceedings . Bristol, England, University of Bristol, 1985, p. 21.1-21.13. SERC-supported research. refs

The 'Machan' RPV was designed to serve as an R&D vehicle for the development of flight control laws as well as for surveillance duties. Using comparatively modest computing power, a simulation of the Machan RPV has been developed which allows the assessment of aircraft performance on-line in both open loop and closed loop configurations. The simple control structure obtained furnishes a baseline stability augmentation system, and is used as an inner loop design. O.C.

A86-37407#

DESIGN FEATURES OF AUTOMATIC CONTROL SYSTEM OF D-4 RPV

W. XIE and B. LIU Northwestern Polytechnical University, Journal, vol. 4, April 1986, p. 217-226. In Chinese, with abstract in English. refs

Design features incorporated into the Chinese D-4 remotely piloted vehicle (RPV) to achieve stable flight and a vertical orientation for the on-board instrumentation are described, along with the results of several aerial surveys with differrent instruments. Trackkeeping performance of the RPV has reached a 25 m accuracy by equipping the aircraft with a laser range finder and an autopilot. The pitch and bank angles of the platform have been stabilized to 2 deg within the vertical using low-cost components. Installation of an on-board cesium light pump magnetic probe has permitted aeromagnetic prospecting at a scale of 1:10,000. Aerophotogrammetry has been performed at a scale of 1:20,000 for examining soil erosion around the Yellow River. M.S.K.

A86-37828#

A METHOD FOR ESTIMATING JET REACTION CONTROL EFFECTIVENESS

R. E. KUHN IN: Applied Aerodynamics Conference, 4th, San Diego, CA, June 9-11, 1986, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1986, p. 237-242. Research supported by Rockwell International Corp. refs

(AIAA PAPER 86-1805)

The interaction of the free stream with the jet flow from reaction jets used for control of V/STOL and STO-VL aircraft in hover and transition can reduce the effectiveness of these controls. The limited data available on effects of jet location on the effectiveness of jet reaction control are examined and a method for estimating the loss in effectiveness is presented. The empirical method is based on the data from only two investigations. Additional studies are needed to verify the range of applicability. Author

A86-38323

WIND SHEAR STUDIES AND COCKPIT INTEGRATION

C. R. HIGGINS (Boeing Commercial Airplane Co., Seattle, WA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 13 p.

(SAE PAPER 851812)

Starting with a brief review of the history of wind shear-related accidents and incidents over the last 20 years, the pilot view of the wind shear encounter from the cockpit will be presented. With this view as the basis, the human-factors aspect of the wind shear encounter will be discussed. Based on this insight, cockpit systems developed to aid the crew in an inadvertent wind shear encounter will be reviewed. Author

A86-38329* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

PIVOTABLE STRAKES FOR HIGH ANGLE OF ATTACK CONTROL

P. J. BOBBITT and J. T. FOUGHNER, JR. (NASA, Langley Research Center, Hampton, VA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 13 p. refs

(SAE PAPER 851821)

A series of pivotable strakes have been tested in combination with a 44-deg swept wing to determine their ability to provide pitch control at high angles of attack. The tests were carried out in the Langley 7 X 10-Foot High-Speed tunnel at nominal Mach numbers of 0.3 to 0.4. A total of five strakes with various aspects ratios and shapes were tested at negative deflection angles of 5, 10, 15, and 20 deg through an angle of attack range up to approximately 50 deg. In addition, a cranked delta wing with 70-deg sweep was tested with two different pivotable apex flaps. This paper shows lift, drag and moment data for the complete configurations as well as for the separate contributions of the strakes and fuselage nose which are mounted on a second balance. Generally, strake deflection was found to have a significant effect on moment while lift/drag changed very little. Author

A86-38331

APPLICATION OF ANALYTICAL REDUNDANCY

R. C. HENDRICK (Honeywell, Inc., Minneapolis, MN) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 9 p.

(SAE PAPER 851825)

Analytical redundancy involves the use of diagnostic routines in software to detect a fault in a set of sensor signals. The fault detection algorithms and associated redundancy management structure are presented within. The DIGITAC application improved the mission reliability of existing dual mission-essential sensors by effecting a single-fail-operative capability. Flight safety was preserved for single sensors. Fault detection qualities of the diagnostics were satisfactory. False alarm problems required considerable redesign and tuning to properly model the processes. These problems were satisfactorily solved with the exception of

diagnostic errors occurring during extreme turbulence (e.g., penetration of jetwash). Author

A86-38332
DIGITAC MULTIMODE CONTROL LAWS
R. C. HENDRICK (Honeywell, Inc., Minneapolis, MN) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 12 p.
(SAE PAPER 851826)

The DIGITAC system executes multiple control laws, each tailored to specific mission tasks. The available augmentation modes include the standard control augmentation mode for the A-7D aircraft, a 'flight path' mode, and a 'precision attitude' mode. Synthesis and development of the control laws for these modes are described within this paper. Also described are unique filtering, amplitude sensitive performance, and robust directional control. It was demonstrated that the standard flight modes were executed by the digital system in an un-degraded manner. Major performance improvements were produced for gunnery tasks by the precision attitude mode. Author

A86-38333
USAF TEST PILOT SCHOOL USE OF DIGITAC IN SYSTEMS TESTING
D. R. FURMAN (USAF, Test Pilot School, Edwards AFB, CA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 12 p.
(SAE PAPER 851827)

The U.S. Air Force Test Pilot School has employed the YA-7D DIGITAC in its curriculum since 1976. To date a dozen projects have been carried out by student classes using the DIGITAC, investigating improved directional control, the effect of depressed roll axis on air-to-air tracking, and airborne verification of computer-simulated flying qualities. Future tests will help to provide answers to questions arising during the design and testing of new highly augmented flight control systems. Author

A86-38930#
A WIND TUNNEL STUDY OF ACTIVE CONTROL TECHNOLOGY ON A HIGH ASPECT RATIO WING
H. HORIKAWA and K. SAITO (Kawasaki Heavy Industries, Ltd., Aircraft Engineering Div., Kakamigahara, Japan) IN: Structures, Structural Dynamics and Materials Conference, 27th, San Antonio, TX, May 19-21, 1986, Technical Papers. Part 2 . New York, American Institute of Aeronautics and Astronautics, 1986, p. 484-492. Research supported by the Society of Japanese Aerospace Companies. refs
(AIAA PAPER 86-0956)

Gust load alleviation (GLA) and flutter mode control (FMC) of a transport wing have been studied in a low speed wind tunnel. A 1/9 scale semispan wing model, which represents a 150-passenger transport, is mounted in the wind tunnel and controlled by a trailing-edge control surface activated electrically. A gust for the gust load alleviation test is generated through the use of both a fluttering banner and a grid. Digital control utilizing a microcomputer is employed for implementing the flutter mode control. The objectives of this study are the development of a low-budget wind tunnel model with active controls as well as a demonstration of the effectiveness of gust load alleviation and flutter mode control on the transport wing. A modified linear quadratic Gaussian (LQG) synthesis procedure has been used to design low-order robust controllers for the flutter mode control. In general, analytical results are in good agreement with experimental ones. Author

A86-38932#
DYNAMIC INTERACTIONS BETWEEN ACTIVE CONTROL SYSTEMS AND A FLEXIBLE AIRCRAFT STRUCTURE
R. FREYMANN (DFVLR, Institut fuer Aeroelastik, Goettingen, West Germany) IN: Structures, Structural Dynamics and Materials Conference, 27th, San Antonio, TX, May 19-21, 1986, Technical Papers. Part 2 . New York, American Institute of Aeronautics and Astronautics, 1986, p. 517-524. refs
(AIAA PAPER 86-0960)

Analytical and experimental results from three different research programs in the field of active control are presented. Attention is focussed on special problems related to interaction effects between active control systems and aircraft structures. Furthermore, various viewpoints for the design of active control systems are illustrated and the extent to which adaptive control systems can contribute to an improvement of the stability margins of such systems is shown. Author

A86-38946*# PRC Kentron, Inc., Hampton, Va.
INTEGRATED AEROSERVOELASTIC TAILORING OF LIFTING SURFACES
T. A. ZEILER (PRC-Kentron, Inc., Hampton, VA) and T. A. WEISSHAAR (Purdue University, West Lafayette, IN) IN: Structures, Structural Dynamics and Materials Conference, 27th, San Antonio, TX, May 19-21, 1986, Technical Papers. Part 2 . New York, American Institute of Aeronautics and Astronautics, 1986, p. 654-663. refs
(Contract NAG1-157)
(AIAA PAPER 86-1005)

An approach to the integration of two design activities, structural design and active control design, for a highly idealized aeroservoelastic system is presented. The particular design goal for this study is the maximization of the stable airspeed envelope of an idealized model of an aeroservoelastic system through rational and systematic variation of structural and control design parameters. The steady-state linear quadratic regulator is used to model the control subsystem; the structural subsystem is assigned characteristic design parameters, such as shear center position. The application of the procedure described here produces optimally controlled structures with stability characteristics superior to those of open-loop and initial closed-loop designs. V.L.

A86-39041#
DESIGN OF A FLUTTER MODE CONTROLLER USING POSITIVE REAL FEEDBACK
G. L. SLATER (Cincinnati, University, OH) and M. TAKAHASHI (Guidance and Control Conference, Seattle, WA, August 20-22, 1984, Technical Papers, p. 246-253) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 9, May-June 1986, p. 339-345. Previously cited in issue 21, p. 2999, Accession no. A84-43427. refs
(Contract F33615-82-K-3609)

A86-39042*# Purdue Univ., West Lafayette, Ind.
FREQUENCY DOMAIN SYNTHESIS OF A ROBUST FLUTTER SUPPRESSION CONTROL LAW
D. K. SCHMIDT (Purdue University, West Lafayette, IN) and T. K. CHEN (Lear Siegler, Inc., Dayton, OH) (Structures, Structural Dynamics, and Materials Conference, 26th, Orlando, FL, April 15-17, 1985, Technical Papers. Part 2, p. 459-467) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 9, May-June 1986, p. 346-351. Previously cited in issue 13, p. 1850, Accession no. A85-30373. refs
(Contract NAG1-157)

A86-39043#
CLASSICAL FLIGHT DYNAMICS OF A VARIABLE FORWARD-SWEEP-WING AIRCRAFT
R. L. SWAIM (Oklahoma State University, Stillwater) and B. A. NEWMAN Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 9, May-June 1986, p. 352-356. refs

The X-29 advanced technology demonstrator has established the design of forward-sweep wings. A conceivable variation of

forward sweep is variable forward sweep. A variable forward-sweep configuration would likely offer higher performance levels than either forward sweep or variable sweep. The classical flight dynamics for such a configuration are determined and discussed. A classical aircraft stability analysis assuming rigid body, linearized dynamics, and no stability augmentation is used. Results indicated variable forward-sweep configurations can have less of a problem with excessive static margins than variable backward-sweep configurations. Wing location and center of gravity location changes due to variable forward sweep affect the stability derivatives consistently more than the wing shape changes due to variable forward sweep. The steady state trim condition and moments of inertia changes due to variable forward sweep and Mach number are small. The phugoid and roll modes experience the largest effects due to variable forward sweep and Mach number. The average handling quality levels experience no drastic changes due to variable forward sweep and Mach number. Author

A86-39768#

THE EQUIVALENT DETERMINISTIC FUNCTION OF THE DRYDEN'S SPECTRA OF ATMOSPHERIC TURBULENCE AND ITS APPLICATION TO THE AIRCRAFT RESPONSE PROBLEM

Y. XIAO (Beijing Institute of Aeronautics and Astronautics, People's Republic of China) Acta Aeronautica et Astronautica Sinica, vol. 7, April 1986, p. 198-204. In Chinese, with abstract in English.

The equivalent deterministic input technique (EDIT) for multiinput-random processes published recently by Etkin et al. (1984) is reviewed briefly in this paper. Then, a formula of linear transformation is derived and the singularity of the equivalent input function is shown. By analyzing the characteristics of the turbulence spectral matrix for the longitudinal motion of an aircraft, including two gust velocities and one gust gradient, it turns out that only two (rather than three) equivalent input vectors are needed. The Dryden spectra of atmospheric turbulence in current use are decomposed into U11, U22, U33, and the inversed Fourier transform is subsequently performed to obtain the equivalent deterministic function u11, u22, u32 for the reference flight condition. These curves are then fitted by simple expressions. The method and procedure for numerical computation or simulation of the aircraft response to turbulence in the time domain are proposed and discussed. A numerical example is given for comparing the results from the EDIT and the power spectral technique. Author

N86-26339*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

DECOUPLING CONTROL SYNTHESIS FOR AN OBLIQUE-WING AIRCRAFT

G. S. ALAG (University of Western Michigan, Kalamazoo), R. W. KEMPEL, and J. W. PAHLE Jun. 1986 12 p refs Presented at the American Control Conference, Seattle, Wash., 18-20 Jun. 1986

(NASA-TM-86801; H-1339; NAS 1.15:86801) Avail: NTIS HC A02/MF A01 CSCL 01C

Interest in oblique-wing aircraft has surfaced periodically since the 1940's. This concept offers some substantial aerodynamic performance advantages but also has significant aerodynamic and inertial cross-coupling between the aircraft longitudinal and lateral-directional axes. This paper presents a technique for synthesizing a decoupling controller while providing the desired stability augmentation. The proposed synthesis procedure uses the concept of a real model-following control system. Feedforward gains are selected on the assumption that perfect model-following conditions are satisfied. The feedback gains are obtained by using eigensystem assignment, and the aircraft is stabilized by using partial state feedback. The effectiveness of the control laws developed in achieving the desired decoupling is illustrated by application to linearized equations of motion of an oblique-wing aircraft for a given flight condition. Author

N86-26340*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

AEROELASTIC CONTROL OF OBLIQUE-WING AIRCRAFT

J. J. BURKEN, G. S. ALAG, and G. B. GILYARD (University of Western Michigan, Kalamazoo) Jun. 1986 12 p refs Presented at the American Control Conference, Seattle, Wash., 18-20 Jun. 1986

(NASA-TM-86808; H-1346; NAS 1.15:86808) Avail: NTIS HC A02/MF A01 CSCL 01B

The U.S. Navy and NASA are currently involved in the design and development of an unsymmetric-skew-wing aircraft capable of 65 deg wing sweep and flight at Mach 1.6. A generic skew-wing aircraft model was developed for 45 deg wing skew at a flight condition of Mach 0.70 and 3048 m altitude. At this flight condition the aircraft has a wing flutter mode. An active implementable control law was developed using the linear quadratic Gaussian design technique. A method of modal residualization was used to reduce the order of the controller used for flutter suppression. Author

N86-26341*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

VALIDATION OF A NEW FLYING QUALITY CRITERION FOR THE LANDING TASK

D. T. BERRY and S. K. SARRAFIAN 1986 10 p Presented at the AIAA Atmospheric Flight Mechanics Conference, Williamsburg, Va., 18-20 Aug. 1986

(NASA-TM-88261; H-1357; NAS 1.15:88261; AIAA-86-2126-CP) Avail: NTIS HC A02/MF A01 CSCL 01C

A strong correlation has been found to exist between flight path angle peak overshoot and pilot ratings for the landing task. The use of flightpath overshoot as a flying quality metric for landing is validated by correlation with four different in-flight simulation programs and a ground simulation study. Configurations tested were primarily medium-weight generic transports. As a result of good correlation with this extensive data base, criterion boundaries are proposed for landing based on the flight path peak overshoot metric. Author

N86-26342*# Kansas Univ. Center for Research, Inc., Lawrence. Flight Research Lab.

STUDY ON USING A DIGITAL RIDE QUALITY AUGMENTATION SYSTEM TO TRIM AN ENGINE-OUT IN A CESSNA 402B

K. E. DONALDSON 1986 37 p refs

(Contract NAG1-345)

(NASA-CR-177272; NAS 1.26:177272; KU-FRL-6132-3) Avail: NTIS HC A03/MF A01 CSCL 01C

A linear model of the Cessna 402B was used to determine if the control power available to a Ride Quality Augmentation System was adequate to trim an engine-out. Two simulations were completed: one using a steady state model, and the other using a state matrix model. The amount of rudder available was not sufficient in all cases to completely trim the airplane, but it was enough to give the pilot valuable reaction time. The system would be an added measure of safety for only a relatively small amount of development. Author

N86-26343# National Aerospace Lab., Amsterdam (Netherlands). Flight Div.

FAILURES IN ADVANCED FLIGHT CONTROL SYSTEMS OF FUTURE TRANSPORT AIRCRAFT

M. F. C. VANGOOL and W. W. RICKARD (McDonnell-Douglas Corp., Long Beach, Calif.) 12 Nov. 1984 187 p refs

(Contract NIVR-1745; RB-RLD-84/83-1.3.1)

(NLR-TR-84108-U; ESA-86-96983) Avail: NTIS HC A09/MF A01

Failure probability and the effects of flight control system failures on handling qualities of a medium-weight transport with reduced stability equipped with a side-stick controlled fly-by-wire flight control system were studied in a flight simulator. A very simple electrical back-up system was used to reduce the pitch divergence when the primary flight control system failed. Results indicate that a large variability in pilot ratings can occur in this kind of investigation. However, analysis of the ratings and the associated

commentary provides a ranking of the configurations used from good to bad. The results are compared to the existing criteria for handling qualities. It is shown that the rankings correlate well with closed-loop performance criterion, and Mil-F-8785 C criteria, whereas other criteria are either not applicable (time history criteria), or inappropriate (static stability criterion, bandwidth criterion).
ESA

N86-27289# National Aeronautical Lab., Bangalore (India). Aerodynamics Div.
A COMPUTER PROGRAMME FOR DATCOM METHODS OF ESTIMATION OF LATERAL STABILITY AND CONTROL DERIVATIVES
S. RAMABHADRAN and H. SUNDARAMURTHY Mar. 1986 46 p
(NAL-TM-AE-8601) Avail: NTIS HC A03/MF A01

A computer code has been developed to estimate the lateral stability and control derivatives of aircraft configuration. The code, in general, is based on USAF DATCOM methods; in the case of a few derivatives, some approximate relations are used. The code estimates nine important lateral derivatives and five control derivatives. A brief review of the methods along with the limitations of DATCOM are presented. A comparison between the results of the code with those of the working examples of DATCOM are given for some cases. Application of the code for typical configurations is discussed.
Author

N86-27290*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
HIGHLY MANEUVERABLE AIRCRAFT TECHNOLOGY (HIMAT) FLIGHT-FLUTTER TEST PROGRAM
M. W. KEHOE May 1984 20 p
(NASA-TM-84907; H-1183; NAS 1.15:84907) Avail: NTIS HC A02/MF A01 CSCL 01C

The highly maneuverable aircraft technology (HiMAT) vehicle was evaluated in a joint NASA and Air Force flight test program. The HiMAT vehicle is a remotely piloted research vehicle. Its design incorporates the use of advanced composite materials in the wings, and canards for aeroelastic tailoring. A flight-flutter test program was conducted to clear a sufficient flight envelope to allow for performance, stability and control, and loads testing. Testing was accomplished with and without flight control-surface dampers. Flutter clearance of the vehicle indicated satisfactory damping and damping trends for the structural modes of the HiMAT vehicle. The data presented include frequency and damping plotted as a function of Mach number.
Author

09

RESEARCH AND SUPPORT FACILITIES (AIR)

Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tube facilities; and engine test blocks.

A86-37176
AEROSPACE SIMULATION II; PROCEEDINGS OF THE SECOND CONFERENCE, SAN DIEGO, CA, JANUARY 23-25, 1986
M. UNG, ED. (Southern California, University, Los Angeles, CA) San Diego, CA, Society for Computer Simulation (Simulation Series. Volume 16, No. 2, 1986), 1986, 304 p. For individual items see A86-37177 to A86-37195.

Papers are presented on techniques for optimizing computer performance in real-time flight simulation; the effects of simulator variation on the fidelity of a UH-60 Black Hawk simulation; a real-time simulation for helicopter rotor wind-tunnel operations; simulation support software in a real-time environment; simulation of auto-rendezvous and docking; a generic missile weapon system model for war-gaming; and the optimal missile nonlinear multiloop controller design principle. Topics discussed include the modeling of a tethered two-body system in space; the testing of a spacecraft attitude control system; Space Station dynamic modeling; interactive mission planning for a Space Shuttle flight experiment; hybrid simulation of ejection seat dynamics, adaptive autoregressive target modes' identification; and optimal control of air-launched homing missiles using realistic performance indices. Consideration is given to flow separation and dynamic stall research, transonic trailing edge flow, fluid dynamics, man/machine interface, computer generated image time delays, the simulation of a satellite attitude control system, and the application of flight simulators to the development of advanced fighter flight control.
I.F.

A86-37178* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
EFFECTS OF SIMULATOR VARIATIONS ON THE FIDELITY OF A UH-60 BLACK HAWK SIMULATION
W. B. CLEVELAND (NASA, Ames Research Center, Moffett Field, CA) and A. ATENCIO, JR. (NASA, Ames Research Center; U.S. Army, Aeroflightdynamics Directorate, Moffett Field, CA) IN: Aerospace simulation II; Proceedings of the Second Conference, San Diego, CA, January 23-25, 1986 . San Diego, CA, Society for Computer Simulation, 1986, p. 13-26. refs

The validity of the vertical motion simulator used to simulate the UH-60A Black Hawk helicopter is evaluated. Aircraft simulation of bob-up, hover turn, and dash/quick stop manuevers are compared to actual flight data. The effects of variations in the simulator's visual and motion characteristics on the simulation data are investigated. Data obtained with the nonintrusive parameter identification procedure and optimal control measures are applied to the helicopter math model used for real-time aircraft simulation. Analysis of the model reveals that the simulated aircraft is underdamped, and the changes in the visual reference have the greatest effect on the ability of the pilot to perform the maneuvers.
I.F.

A86-37179* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
REAL-TIME SIMULATOR FOR HELICOPTER ROTOR WIND-TUNNEL OPERATIONS
P. D. TALBOT, R. L. PETERSON, and D. R. GRAHAM (NASA, Ames Research Center, Moffett Field, CA) IN: Aerospace simulation II; Proceedings of the Second Conference, San Diego, CA, January 23-25, 1986 . San Diego, CA, Society for Computer Simulation, 1986, p. 27-40.

This paper describes the elements and operation of a simulator that is being used to train operators of the Rotor Test Apparatus (RTA) in the large-scale 40- by 80-Foot Wind Tunnel at Ames Research Center. The simulator, named TUTOR (for Tunnel Utilization Trainer with Operating Rotor) duplicates the controls of the rotor and its dynamic behavior, as well as the wind-tunnel controls. The simulation software uses a preexisting blade-element model of a four-bladed rotor with flapping and lead-lag degrees of freedom. Equations were developed for all hardware and controls of the RTA and of the wind tunnel that are normally required to perform a wind-tunnel test of a helicopter rotor. The simulator hardware consists of consoles designed to have the same appearance and functions as those in the control room of the 40- by 80-Foot Wind Tunnel, allowing input from three operators who normally establish the required operating conditions during a test run. Normal operating procedures can be practiced, as well as simulated emergencies such as rotor power failure.
Author

A86-37337
A NEW COMPRESSED AIR LAUNCHING SYSTEM
C. I. CAMPBELL (GQ Defence Equipment, Ltd., Goldaming, England) IN: Remotely piloted vehicles; International Conference, 5th, Bristol, England, September 9-11, 1985, Proceedings . Bristol, England, University of Bristol, 1985, p. 25.1-25.15.

Attention is given to the development history, design features and performance capabilities of a pneumatic catapult launching system for RPVs of up to 150 kg. The primary system components of the launcher are a pneumatic charge reservoir, a quick-opening valve, a pneumatic cylinder, a drive piston/carriage assembly, and

a buffer. The system operates at less than 10-bar pressures, allowing a range of low cost pneumatic components to be used. O.C.

A86-38069

DOUGLAS AUTOMATED WEIGHING SYSTEM

C. R. SOLT, JR. (Douglas Aircraft Co., Long Beach, CA) IN: International Instrumentation Symposium, 31st, San Diego, CA, May 6-9, 1985, Proceedings . Research Triangle Park, NC, Instrumentation Society of America, 1985, p. 485-499.

The Douglas Automated Weighing System (DAWS), a new state-of-the-art system for weighing aircraft, is described. DAWS eliminates tedious manual weight calculations by using a computer. All aircraft data, platform data, load cell data, and setup configurations can be stored on a single disk. A truck provides portability, so that DAWS can be taken to the aircraft rather than vice versa. The DAWS hardware and software are described in this paper. C.D.

A86-38070

A NEW APPROACH TO AUTOMATED GAS TURBINE ENGINE TESTING

D. A. GRAVES and T. L. BORMAN (General Motors Corp., Allison Gas Turbine Div., Indianapolis, IN) IN: International Instrumentation Symposium, 31st, San Diego, CA, May 6-9, 1985, Proceedings . Research Triangle Park, NC, Instrumentation Society of America, 1985, p. 501-524.

An automated gas turbine engine testing system, Test Stand (TS) 862, for unattended testing is described. The monitor and control system for TS 862 incorporates a Modvue industrial graphics processing system, three Intel single board computers, and a programmable controller. The Modvue system consists of a color monitor for display of engine parameters, and a second color monitor with a touch-sensitive screen for display of critical engine parameters and operator interface with engine testing. The new test system will provide greater safety for the engine by providing automatic engine shutdown. It will also reduce labor costs incurred when the engine cannot be run, by providing a detailed explanation of where the problems have occurred. Schematics and block diagrams are included. I.S.

A86-38076* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

NATIONAL TRANSONIC FACILITY MACH NUMER SYSTEM

F. A. KERN, C. W. KNIGHT, and R. F. ZASIMOWICH (NASA, Langley Research Center, Hampton, VA) IN: International Instrumentation Symposium, 31st, San Diego, CA, May 6-9, 1985, Proceedings . Research Triangle Park, NC, Instrumentation Society of America, 1985, p. 643-652.

The Mach number system for the Langley Research Center's National Transonic Facility was designed to measure pressures to determine Mach number to within + or - 0.002. Nine calibration laboratory type fused quartz gages, four different range gages for the total pressure measurement, and five different range gages for the static pressure measurement were used to satisfy the accuracy requirement over the 103,000-890,000 Pa total pressure range of the tunnel. The system which has been in operation for over 1 year is controlled by a programmable data process controller to select, through the operation of solenoid valves, the proper range fused quartz gage to maximize the measurement accuracy. The pressure gage's analog outputs are digitized by the process controller and transmitted to the main computer for Mach number computation. An automatic two-point on-line calibration of the nine quartz gages is provided using a high accuracy mercury manometer. Author

A86-38228

INSTRUMENTATION AND TESTING TECHNIQUES IN THE T2 TRANSONIC CRYOGENIC WIND TUNNEL AT THE ONERA/CERT

J. P. ARCHAMBAUD, A. BLANCHARD, and A. SERAUDIE (ONERA, Centre d'Etudes et de Recherches de Toulouse, France) IN: ICIASF '85 - International Congress on Instrumentation in Aerospace Simulation Facilities, 11th, Stanford, CA, August 26-28, 1985, Record . New York, Institute of Electrical and Electronics Engineers, 1985, p. 9-25. refs

In the T2 transonic wind tunnel considered, unconfined two-dimensional flow is obtained by moving solid top and bottom walls in the context of an iterative process, while the Reynolds number is increased by making use of cryogenic operation. The theoretical and practical principles involved in the employment of 'adaptive walls' are discussed. In a limited test section, unconfined flow around the model is established by controlling wall conditions, taking into account mass flow through slotted walls and changes in the shape of solid walls. Attention is given to control surface, real flow, virtual flow, the inverse mode, the employment of the Green transform with the Prandtl-Glauert rule, an adaptation flowchart, the constructional features of the T2 two-dimensional test section, and test results. Cryogenic models and their equipment are considered along with complementary instrumentation for flow measurements, and the results of measurements and calibrations. G.R.

A86-38248

INSTRUMENTATION AND OTHER ISSUES IN NON-LINEAR DYNAMIC TESTING IN WIND TUNNELS

E. S. HANFF, S. JENKINS, and A. PRINI (National Research Council of Canada, Ottawa) IN: ICIASF '85 - International Congress on Instrumentation in Aerospace Simulation Facilities, 11th, Stanford, CA, August 26-28, 1985, Record . New York, Institute of Electrical and Electronics Engineers, 1985, p. 200-208. refs

The locally linearized aerodynamic model embodied in the stability derivatives formulation does not appear adequate to deal with severe nonlinear situations, such as encountered in flight at high angles of attack, and Hanff (1985) has proposed an approach for the representation of dynamic nonlinear aerodynamic reactions. The data needed for this approach can be obtained with the aid of an efficient wind-tunnel technique proposed by Hanff (1983). A summary of the principles of the wind-tunnel technique is presented, and an instrumentation system which has been implemented is briefly described. Attention is also given to a dynamic calibrator and its new electronic system, wind-tunnel apparatus, the representation of aerodynamic reactions, and aspects of simulation. G.R.

A86-38252

A HOT AIR TUNNEL FOR BASE BLEED EXPERIMENTATION

H. V. HATTINGH, D. VAN V. PIENAAR, and L. R. BOSCH (Stellenbosch, University, Republic of South Africa) IN: ICIASF '85 - International Congress on Instrumentation in Aerospace Simulation Facilities, 11th, Stanford, CA, August 26-28, 1985, Record . New York, Institute of Electrical and Electronics Engineers, 1985, p. 233-240. refs

A thorough understanding of base bleed as applied to cannon shells to extend their range was to be obtained. After an evaluation of published information and approaches available to obtain such an understanding, it appeared to be essential to build a wind tunnel in which both the real stagnation pressure and the stagnation temperature could be simulated. On the basis of cost considerations, it was decided to provide a round test section of 150 mm. A range of Mach numbers and temperatures as a function of altitude had to be simulated. The Mach numbers were in the range from 3 (at sea level) to approximately 1 (barely supersonic). Direct heating was provided with the aid of a conduction heater. Attention is given to experimental equipment and experimental program. The relatively small effect of the rotational speed appears surprising. G.R.

A86-38253
WIND TUNNEL FREE-FLIGHT TEST BY A VERTICAL DROP TECHNIQUE AT A HYPERSONIC MACH NUMBER OF 7
K. HOZUMI (National Aerospace Laboratory, Tokyo, Japan) IN: ICIASF '85 - International Congress on Instrumentation in Aerospace Simulation Facilities, 11th, Stanford, CA, August 26-28, 1985, Record . New York, Institute of Electrical and Electronics Engineers, 1985, p. 241-250. refs

As aerodynamic data obtained in a conventional wind tunnel are affected by the model support system, free-flight techniques are utilized to obtain data free from support-interference effects. An investigation was conducted regarding the practicability of the vertical drop method as a free-flight testing technique under hypersonic flow conditions. It was found that the employment of the considered method in a hypersonic wind tunnel with free-jet main flow provided a very useful and efficient approach to the acquisition of aerodynamic coefficients of bodies in motion having linear or nearly linear aerodynamic characteristics. Attention is given to the wind tunnel, the models, the test procedure, aspects of data reduction, a simulated data study, and a comparison between aerodynamic models. G.R.

A86-38301
ALPHA JET TRAINING SYSTEM SINGLE AIRCRAFT CONCEPT
C. A. BARENYI and G. BENATTI (Dornier GmbH, Friedrichshafen, West Germany) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 8 p.
(SAE PAPER 851766)

The Alpha Jet Training System as a single aircraft concept consists of the training management system and media for the following: academics, simulators, and aircraft. It meets or exceeds all requirements for: (1) timely replacement of obsolete training system components, (2) effective and efficient management in the training of individual pilots, and (3) optimum employment of all components of the training system. It significantly lowers pilot training costs and personnel support requirements through the use of computer assisted instruction and procedure devices, the use of a training management system, and a modern high performance training aircraft with state-of-the-art simulators. Author

A86-38319
GROUND TESTING APPROACH FOR THE B-1B BOMBER
R. A. MORLEY (Teledyne Sprague Engineering, Gardena, CA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 12 p.
(SAE PAPER 851796)

Existing methods for production ground testing of the B-1B would create an undesirable and cumbersome work environment. The noise generated by the equipment along with hoses, cables and ducts on the floor produce a safety hazard. The information presented here deals with a new approach to meet the aircraft delivery rate requirement. Goals were established and review of existing methods provided the 'stepping stones' to the solution. The use of high technology computer applications is discussed along with the equipment types used on the B-1B bomber. This is the first automated approach to ground testing and checkout of complex aircraft mechanical systems. Author

A86-38370
LABORATORY SIMULATION OF LANDING GEAR PITCH-PLANE DYNAMICS
J. J. ENRIGHT (BF Goodrich Co., Aerospace and Defense Div., Akron, OH) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 12 p. refs
(SAE PAPER 851937)

A technique for laboratory dynamometer simulation of landing gear-brake dynamics is discussed. The method was developed as a means of improving certain limitations of conventional dynamometer testing with and without actual strut hardware. The test fixture, the basis for its similitude, assumptions, and design criteria are described. Background includes descriptions of the form and significance of brake-induced vibration and the concept of a critical torque-speed slope as it relates to system stability criteria. Use of this fixture enables the duplication of brake squeal modes otherwise masked by standard dynamometer fixturing. The large linear range of amplitude and damping permit operation in a deliberately unstable condition to verify stability margins. Examples of the application and verification of the technique are included. Author

A86-38371* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
AIRCRAFT LANDING DYNAMICS FACILITY - A UNIQUE FACILITY WITH NEW CAPABILITIES
P. A. DAVIS, S. M. STUBBS, and J. A. TANNER (NASA, Langley Research Center, Hampton, VA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 9 p.
(SAE PAPER 851938)

The Aircraft Landing Dynamics Facility (ALDF), formerly called the Landing Loads Track, is described. The paper gives a historical overview of the original NASA Langley Research Center Landing Loads Track and discusses the unique features of this national test facility. Comparisons are made between the original track characteristics and the new capabilities of the Aircraft Landing Dynamics Facility following the recently completed facility update. Details of the new propulsion and arresting gear systems are presented along with the novel features of the new high-speed carriage. The data acquisition system is described and the paper concludes with a review of future test programs. Author

A86-39948*# Massachusetts Inst. of Tech., Cambridge.
EXPERIMENTAL MEASUREMENTS OF HEAT TRANSFER FROM AN ICED SURFACE DURING ARTIFICIAL AND NATURAL CLOUD ICING CONDITIONS
M. S. KIRBY and R. J. HANSMAN, JR. (MIT, Cambridge, MA) AIAA and ASME, Joint Thermophysics and Heat Transfer Conference, 4th, Boston, MA, June 2-4, 1986. 11 p. FAA-supported research. refs
(Contract NGL-22-009-640; NAG3-666)
(AIAA PAPER 86-1352)

The heat transfer behavior of accreting ice surfaces in natural (flight test) and simulated (wind tunnel) cloud icing conditions have been studied. Observations of wet and dry ice growth regimes as measured by ultrasonic pulse-echo techniques were made. Observed wet and dry ice growth regimes at the stagnation point of a cylinder were compared with those predicted using a quasi steady-state heat balance model. A series of heat transfer coefficients were employed by the model to infer the local heat transfer behavior of the actual ice surfaces. The heat transfer in the stagnation region was generally inferred to be higher in wind tunnel icing tests than in natural, flight, icing conditions. Author

N86-26344# Dayton Univ., Ohio.
FLIGHT SIMULATOR: COMPARISON OF RESOLUTION THRESHOLDS FOR TWO LIGHT VALVE VIDEO PROJECTORS Final Report, Oct. 1984 - Aug. 1985
P. M. CRANE, J. P. GERLICHER, and H. H. BELL Jan. 1986 15 p refs
(Contract F33615-78-C-0026; F33615-84-C-0066)
(AD-A164577; AFHRL-TP-85-43) Avail: NTIS HC A02/MF A01 CSCL 14B

The Air Force Human Resources Laboratory/Operations Training Division is developing a visual system for advanced tactical air combat simulators. As part of this work, two light valve video projectors were evaluated on their ability to display small, high-contrast images. The angular size of the smallest detail which could reliably be identified by an observer was determined for the General Electric PJ5155 and Sodern SVS-14 Video Projectors for stationary and moving targets under a variety of conditions. Several observers evaluated the projectors using variations of the stairstep procedure to determine minimum resolvable target size. For almost all conditions, observers were able to recognize smaller targets on the General Electric system than on the Sodern. With targets moving horizontally, however, minimum resolvable target size for

the General Electric projector was significantly larger than for targets moving vertically or diagonally at the same speed. A hypothesis for this effect is discussed. Author (GRA)

N86-26346# Naval Postgraduate School, Monterey, Calif.
ANALYZING THE COST EFFECTIVENESS OF USING FLIGHT SIMULATORS IN THE ISRAELI AIR FORCE M.S. Thesis
U. ROZEN Dec. 1985 61 p
(AD-A164864) Avail: NTIS HC A04/MF A01 CSCL 05I

During the last decade flight simulators have been increasingly used in the training of Israeli pilots. The increasing cost of a training flying hour, the shrinking training airspace over Israel since 1979, and the high performance standards required of the Israeli Air Force air crews were the accelerator factors in this process. This thesis describes a way to analyze the cost effectiveness of the present mix of flight simulators and flying hours in the training process of the I.A.F. air crews. The jet fighters, helicopters, and transportation communities are used as examples to demonstrate the implementation of the analysis. These examples give the reader a general picture of the cost effectiveness of using flight simulators in the I.A.F. Author (GRA)

N86-27291*# Wichita State Univ., Kans. Dept. of Aeronautical Engineering.
DE-ICING OF THE ALTITUDE WIND TUNNEL TURNING VANES BY ELECTRO-MAGNETIC IMPULSE Final Report
G. W. ZUMWALT and R. ROSS Mar. 1986 79 p
(Contract NAG3-607)
(NASA-CR-177260; NAS 1.26:177260) Avail: NTIS HC A05/MF A01 CSCL 14B

The Altitude Wind Tunnel at the NASA-Lewis facility is being proposed for a refurbishment and moderization. Two major changes are: (1) the increasing of the test section Mach number to 0.90, and (2) the addition of spray nozzles to provide simulation of flight in icing clouds. Features to be retained are the simulation of atmospheric temperature and pressure to 50,000 foot altitude and provision for full-scale aircraft engine operation by the exhausting of the aircraft combustion gases and ingestion of air to replace that used in combustion. The first change required a re-design of the turning vanes in the two corners downstream of the test section due to the higher Mach number at the corners. The second change threatens the operation of the turning vanes by the expected ice build-up, particulary on the first-corner vanes. De-icing by heat has two drawbacks: (1) an extremely large amount of heat is required, and (2) the melted ice would tend to collect as ice on some other surfaces in the tunnel, namely, the tunnel propellers and the cooling coils. An alternate de-icing method had been under development for three years under NASA-Lewis grants to the Wichita State University. This report describes the electro-impulse de-icing (EIDI) method and the testing work done to assess its applicability to wind tunnel turning vane de-icing. Tests were conducted in the structural dynamics laboratory and in the NASA Icing Research Tunnel. Good ice protection was achieved at lower power consumption and at a wide range of tunnel operations conditions. Recommendations for design and construction of the system for this application of the EIDI method are given. Author

N86-27293# Washington Univ., Seattle. Transportation Center.
USE OF NDE TO EVALUATE REFLECTION CRACKING IN AIRFIELD PAVEMENTS Final Report, Feb. - Aug. 1984
D. E. NEWCOMB, J. P. MAHONEY, and J. SHARMA Nov. 1985 129 p
(Contract F08635-84-K-0145)
(AD-A164880; AFESC/ESL-TR-84-42) Avail: NTIS HC A07/MF A01 CSCL 14B

This study reports on the possible use of nondestructive testing equipment to evaluate the potential of reflection cracking in airfield pavements. It also summarizes the state of the art of reflection cracking analysis and methods for controlling reflection cracking. The proposed method of analysis consists of testing portland cement concrete slabs in a curled-up condition at slab centers and slab corners. Increased tensile strains at the bottom of the overlays at slab corners are related to the number of traffic repetitions to predict reflection cracking life. Although the method appears promising, further study is recommended to extend the limited data base presented here and gain added insight into the nature of mechanisms which cause reflection cracking. GRA

N86-27294# Illinois Univ., Urbana. Civil Engineering Lab.
CONCEPTS FOR THE DEVELOPMENT OF A NONDESTRUCTIVE TESTING AND EVALUATION SYSTEM FOR RIGID AIRFIELD PAVEMENTS Final Report, Jan. 1983 - May 1985
P. T. FOXWORTHY Nov. 1985 274 p Previously announced as N86-15324
(Contract F08637-84-M-1743)
(AD-A165055; AFESC/ESL-TR-85-46) Avail: NTIS HC A12/MF A01 CSCL 14B

This technical report develops a complete system for nondestructive testing and evaluation of rigid airfield pavements. An extensvie review of present destructive and nondestructive equipment and methodologies is made to form the basis for selection of the equipment and analytical model used in this research. A brief description of the selected Dynatest Model 8000 Falling Weight Deflectometer (FWD) and the ILLISLAB finite element computer model is presented. Three Air Force installations were chosen for in-depth study of pavement response to FWD loads under a variety of environmental and geological conditions. Techniques are presented to determine the location of maximum damage to rigid pavement slabs for one or any combination of aircraft, and the validity of the calculated stresses is established through comparisons of measured and predicted deflections at joints. Major study findings include: (1) new designations for pavement features based on actual loading conditions, (2) guidelines for planning and conducting large-scale evaluations of major airfield systems, (3) a computer-based determination of E and K, (4) joint behavior prediction under fluctuating temperatures and their effect on generated slab stresses, (5) procedures to account for the annual distribution of traffic over the range of temperatures normally experienced at any facility, and (6) a simplistic means of estimating total past damage from aircraft operations. Author (GRA)

N86-27295# Arnold Engineering Development Center, Arnold Air Force Station, Tenn.
VERIFICATION AND AERODYNAMIC CALIBRATION OF THE TUNNEL 16T CAPTIVE TRAJECTORY SUPPORT (CTS) SYSTEM Final Report, 21 Jul. - 26 Jul. 1985
E. G. ALLEE, JR. and M. L. MILLS Mar. 1986 60 p Prepared in cooperation with Calspan Field Services, Inc., Arnold AFS, Tenn.
(AD-A165235; AEDC-TR-86-4) Avail: NTIS HC A04/MF A01 CSCL 14B

An air-on demonstration of the Captive Trajectory Support (CTS) system was conducted in the Propulsion Wind Tunnel (16T) on July 21 through July 26, 1985. The test objectives were: (1) to demonstrate the structural integrity of the CTS system; (2) to demonstrate the ability of the CTS system to satisfactorily obtain grid and trajectory generation data for a typical shore model in free stream and relative to a simulated (flat plate) aircraft in a dynamic wind tunnel environment; and (3) to obtain a Mach number calibration for the Tunnel 16T Cart 2 (Multi-Purpose Cart) with the CTS system installed. The 1/4-scale Maximum Volume Bomb (MVB) was used to represent a typical store. Data were obtained at free-stream Mach numbers from 0.3 to 1.6 at stagnation pressures from 400 to 1600 psfa. GRA

N86-27296# Messerschmitt-Boelkow-Blohm G.m.b.H., Bremen (West Germany). Unternehmensbereich UT.
DEVELOPMENT, CONSTRUCTION, AND MANUFACTURING OF WIND TUNNEL MODELS FOR AERODYNAMIC INVESTIGATIONS Final Report, Mar. 1984
K. KASZEMEIK Bonn (West Germany) Bundesministerium fuer Forschung und Technologie Nov. 1985 50 p In GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie
(BMFT-FB-W-85-012; ISSN-0170-1339; ESA-86-96887; TE-2-1363) Avail: NTIS HC A03/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 11

Models and model components for aerodynamic research in the European airbus project A-320 were manufactured with a numerical control milling machine and prepared for testing: Three high speed wings IFAS 5, 6, and 6.1; a low speed halfmodel with IFAS 6; a low speed complete model with IFAS 6; a halfmodel as test setup for high and low speed; an A-310 research model for the active tail-section design; and a propulsion simulator were produced. ESA

10

ASTRONAUTICS

Includes astronautics (general); astrodynamics; ground support systems and facilities (space); launch vehicles and space vehicles; space transportation; spacecraft communications, command and tracking; spacecraft design, testing and performance; spacecraft instrumentation; and spacecraft propulsion and power.

A86-38845#
OPTIMUM DESIGN OF LARGE STRUCTURES WITH MULTIPLE CONSTRAINTS
R. A. CANFIELD, V. B. VENKAYYA (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH), and R. V. GRANDHI (Wright State University, Dayton, OH) IN: Structures, Structural Dynamics and Materials Conference, 27th, San Antonio, TX, May 19-21, 1986, Technical Papers. Part 1 . New York, American Institute of Aeronautics and Astronautics, 1986, p. 398-408. USAF-supported research. refs
(AIAA PAPER 86-0952)

Relative numerical efficiencies of different commonly used optimization techniques for solving problems with multiple constraints have been compared with an aim of developing an efficient optimization method for the automated design of large aerospace structures. A hybrid algorithm using both optimality criteria and mathematical programming methods is suggested. As a result of the study, the CONMIN computer program, and possibly NEWSUIT-A, will be used in conjunction with an optimality criteria algorithm built from OPTSTAT to develop the multidisciplinary hybrid optimization algorithm. I.S.

N86-27351*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
PARTICULATE CONTAMINANT RELOCATION DURING SHUTTLE ASCENT
J. J. SCIALDONE Jun. 1986 17 p
(NASA-TM-87794; NAS 1.15:87794; REPT-86B0432) Avail: NTIS HC A02/MF A01 CSCL 22B

The dislodgement, venting, and redeposition of particles on a surface in the shuttle bay by the vibroacoustic, gravitational, and aerodynamic forces present during shuttle ascent have been investigated. The particles of different sizes which are displaced, vented, and redistributed have been calculated; and an estimate of the increased number of particles on certain surfaces and the decrease on others has been indicated. The average sizes, velocities, and length of time for certain particles to leave the bay following initial shuttle doors opening and thermal tests have been calculated based on indirect data obtained during several shuttle flights. Suggestions for future measurements and observations to characterize the particulate environment and the techniques to limit the in-orbit particulate contamination of surfaces and environment have been offered. Author

N86-27354# Rockwell International Corp., Downey, Calif.
OPERATIONAL FLIGHT EXPERIENCE AND DISASSEMBLY/INSPECTION RESULTS OF SPACE SHUTTLE ORBITER ACTUATORS
D. WOOLHOUSE *In* ESA Second European Space Mechanisms and Tribology Symposium p 3-8 Dec. 1985
(Contract NAS9-14000)
Avail: NTIS HC A15/MF A01; ESA, Paris FF 150 or $18 Member States, AU, CN, NO (+20% others)

After completion of the first six flights of Space Shuttle Columbia, the four rudder/speedbrake rotary actuators were removed so that a complete disassembly and inspection could be accomplished to evaluate the condition of all internal components. The flight loads experienced by the actuators are compared to those used in designing them. The combination of materials employed for the gear train and lubrication system of the Space Shuttle rudder/speedbrake rotary actuators successfully withstands all stresses and loads encountered during six orbital flights and six years of environmental exposure. Care should be exercised when choosing off-the-shelf or catalog parts (e.g., bearings, rollers, and spacers) to ensure that the same attention to surface protection is exercised as is typically given to custom designed parts. The requirement imposed on this design for operation during 100 missions over a 10 year period can be met as demonstrated by the excellent condition of these units after their flight exposure. ESA

N86-27406*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
USERS GUIDE: STEADY-STATE AERODYNAMIC-LOADS PROGRAM FOR SHUTTLE TPS TILES
P. A. KERR and D. H. PETLEY Jul. 1984 112 p
(NASA-TM-85724; NAS 1.15:85724) Avail: NTIS HC A06/MF A01 CSCL 22B

A user's guide for the computer program that calculates the steady-state aerodynamic loads on the Shuttle thermal-protection tiles is presented. The main element in the program is the MITAS-II, Martin Marietta Interactive Thermal Analysis System. The MITAS-II is used to calculate the mass flow in a nine-tile model designed to simulate conditions duing a Shuttle flight. The procedures used to execute the program using the MITAS-II software are described. A list of the necessry software and data files along with a brief description of their functions is given. The format of the data file containing the surface pressure data is specified. The interpolation techniques used to calculate the pressure profile over the tile matrix are briefly described. In addition, the output from a sample run is explained. The actual output and the procedure file used to execute the program at NASA Langley Research Center on a CDC CYBER-175 are provided in the appendices. Author

11

CHEMISTRY AND MATERIALS

Includes chemistry and materials (general); composite materials; inorganic and physical chemistry; metallic materials; nonmetallic materials; and propellants and fuels.

A86-37708
ENVIRONMENTAL AND ADHESIVE DURABILITY OF ALUMINIUM-POLYMER SYSTEMS PROTECTED WITH ORGANIC CORROSION INHIBITORS
L. J. MATIENZO, D. K. SHAFFER, W. C. MOSHJIER, and G. D. DAVIS (Martin Marietta Laboratories, Baltimore, MD) Journal of Materials Science (ISSN 0022-2461), vol. 21, May 1986, p. 1601-1608. refs
(Contract N00019-82-C-0439)
The protection of pretreated aluminium against environmental corrosion has been accomplished in varying degrees by incorporating selected organophosphonates and organosilanes on the metal surface. Ionizable phosphonates, such as nitrilo-tris methylene phosphonic acid (NTMP), adsorbed at monolayer concentrations, are effective inhibitors against hydration and are compatible with a nitrile-modified epoxy adhesive material. Aqueous 0.1 vol. pct solution of selected organosilane compounds containing reactive side chains (e.g. epoxy, mercapto) exhibit protection against both hydration corrosion and the action of an aggressive species (Cl) and provide good adhesive bond durability with both nitrile-modified and polyamide (primer) epoxy resin systems. Wedge test results suggest that the curing process (e.g. the percentage crosslinking) of the epoxy-polyamide primer system is not affected by the addition of organosilanes, but may be affected by NTMP. The results of substrate surface characterization, adsorption behavior of applied films, and evaluation of candidate inhibitors by chemical, mechanical, and electrochemical test methods are presented. Mechanisms to explain the observed behavior of the phosphonate and silane systems are discussed. Author

A86-38266
AVIATION FUELS TECHNOLOGY
E. GOODGER (Cranfield Institute of Technology, England) and R. VERE Basingstoke, England, Macmillan Publishers, Ltd, 1985, 278 p. refs
Current data on piston and turbine engines and aviation fuels are investigated. The procedures for the production, finishing processes, and storage of aviation gasolines and kerosines are examined. Methods for testing the composition, volatility, fluidity, combustion, corrosion, stability, and contaminants of fuels are discussed. The fuel characteristics within aircraft fuel systems and fuel combustion performance are analyzed. The development of aviation fuel from shale oil, tar, or coal, and the use of liquefied hydrocarbon gases, liquid hydrogen, hydrocarbon oxygenates, or hydrogen-nitrogen compounds as aviation fuel substitutes are studied. The fuels for ultra-high performance aircraft and rocket propulsion are described. The application of electric, nuclear, or inertial propulsion, and biofuels to aircraft propulsion systems is proposed. I.F.

A86-38309
EFFECTS OF SECTION THICKNESS AND ORIENTATION ON CREEP-RUPTURE PROPERTIES OF TWO ADVANCED SINGLE CRYSTAL ALLOYS
M. DONER and J. A. HECKLER (General Motors Corp., Allison Gas Turbine Div., Indianapolis, IN) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 8 p. Research supported by the General Motors Corp.
(SAE PAPER 851785)
Effects of specimen thickness and orientation on creep and stress-rupture properties of two advanced single crystal alloys were investigated. The alloys were CMSX-3, a derivative of Mar-M247, and a new single crystal alloy, designated 'Alloy X', which is based on modification of IN-792 composition. Section thickness effects were ascertained utilizing four different specimen geometries, including 0.250-in. diameter bars and 0.020-in. thick specimens. The stress-rupture lives of both materials degraded with section thickness at stress levels less than 40,000 lb.sq in. The life degradation was approximately 3X at 20,000 lb/sq in. Investigations into the effects of orientation on stress-rupture properties indicated that, for Alloy X, the 110-oriented specimens suffered a loss of approximately 3X in stress-rupture lives, compared to 001-oriented specimens. On the other hand, essentially no difference was observed in the stress-rupture lives of 001and 110-oriented specimens of CMSX-3 alloy. Time for 1 percent creep was essentially unaffected by section thickness or orientation in both alloys. Author

A86-38384
EVALUATION OF LESS TOXIC FUELS FOR AIRCRAFT EMERGENCY POWER SYSTEMS
R. L. FISCHER (AiResearch Manufacturing Co., Torrance, CA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 7 p.
(SAE PAPER 851974)
Fuel-oxidizer combinations are reviewed as alternates for monopropellant hydrazine for aircraft emergency power systems. Alcohol and oxygen, jet fuel and oxygen or air are evaluated. Author

A86-38529
SOME ASPECTS OF FLUOROCARBON ELASTOMER COMPATIBILITY WITH GAS TURBINE LUBRICANTS
J. W. A. PRAGNELL and J. VAN TILBORG (Castrol, Ltd., Pangbourne, England) IN: Aviation gas turbine lubricants - Military and civil aspects: Aviation fuel and lubricants - Performance testing; Proceedings of the Aerospace Technology Conference and Exposition, Long Beach, CA, October 14-17, 1985 . Warrendale, PA, Society of Automotive Engineers, Inc., 1985, p. 33-57.
(SAE PAPER 851799)
Fluorocarbon elastomers in the form of 'O' ring seals, hoses, etc. are widely used in gas turbine engines and hence come into contact with lubricants approved for use in those engines. Reports of oil/fluorocarbon elastomer incompatibility have been made which have required investigation in order to determine why such problems occur. This paper deals with certain aspects of compatibility investigated by traditional test techniques and reveals some of the complexities of the problem. Author

A86-38531
FORMULATING ADVANCED 4 CENTISTOKE GAS TURBINE OILS - A FEASIBILITY STUDY
Q. E. THOMPSON and R. E. ZIELINSKI (Monsanto Industrial Chemicals Co., St. Louis, MO) IN: Aviation gas turbine lubricants - Military and civil aspects: Aviation fuel and lubricants - Performance testing; Proceedings of the Aerospace Technology Conference and Exposition, Long Beach, CA, October 14-17, 1985 . Warrendale, PA, Society of Automotive Engineers, Inc., 1985, p. 69-75. refs
(SAE PAPER 851833)
A formulation study has been carried out to assess the feasibility of developing advanced gas turbine lubricants in the viscosity range intermediate between current MIL-L-7808 and MIL-L-23699 lubricants (4 centistokes). Using additive technology developed on advanced MIL-L-27502 oils, several 4-centistoke polyol ester-base stocks have been formulated. Eight of the blends thus far tested have shown good to acceptable performance in the Bearing Rig Test run under MIL-L-27502 conditions. Various other key targets of a proposed new specification have been met or closely approached. Author

A86-38532
ADVANCED LUBRICANTS FOR AIRCRAFT TURBINE ENGINES
G. A. BEANE, IV (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, OH), L. J. GSCHWENDER, and C. E. SNYDER, JR. (USAF, Materials Laboratory, Wright-Patterson AFB, OH) IN: Aviation gas turbine lubricants - Military and civil aspects: Aviation fuel and lubricants - Performance testing; Proceedings of the Aerospace Technology Conference and Exposition, Long Beach, CA, October 14-17, 1985 . Warrendale, PA, Society of Automotive Engineers, Inc., 1985, p. 77-94. refs
(SAE PAPER 851834)

An assessment of the performance of oils in Air Force turbine engines and helicopter gear boxes is presented along with predicted performance of current and upgraded military specification oils in advanced and 'growth' engine designs. Data is presented on advanced ester base oils evolving from current research efforts. Future high temperature candidate oils representing the ultimate stability for turbine engines are also discussed. Their use, in most cases, entails engine design considerations to accommodate their unique properties. The advantages and disadvantages of the various classes of synthetic oils for turbine engines are discussed, and deficiencies are identified where additional research programs are needed. Author

A86-38534
ELECTROCHEMICAL EVALUATION OF CORROSIVITY IN TURBINE ENGINE OILS
L. STALLINGS, P. KENNEDY, N. REBUCK, and V. S. AGARWALA (U.S. Navy, Naval Air Development Center, Warminster, PA) IN: Aviation gas turbine lubricants - Military and civil aspects: Aviation fuel and lubricants - Performance testing; Proceedings of the Aerospace Technology Conference and Exposition, Long Beach, CA, October 14-17, 1985 . Warrendale, PA, Society of Automotive Engineers, Inc., 1985, p. 103-108. refs
(SAE PAPER 851867)

This program involves the study of the factors associated with corrosion in turbine engine bearings. Turbine engine oil (MIL-L-23699) used in naval aircraft was found to absorb in excess of 2500 ppm of water at 25 C and 100 percent RH. A mineral oil will absorb in the range of 400 to 500 ppm. This absorbed water causes bearings lubricated with MIL-L-23699 oil to be susceptible to corrosion. A probe which consists of a series of electrochemical galvanic cells is being used to measure corrosion currents developed in high humidity salt air environments. This probe was developed to measure the corrosivity of the naval shipboard environment. Preliminary corrosion current curves have been developed with a bare probe and a probe coated with MIL-L-23699 turbine oil. Studies will be made with MIL-L-23699 base oil and various additives one at a time to determine the effect of each additive in the fluid on corrosion. Author

A86-38535
THE INFLUENCE OF ESTERS ON ELASTOMER SEALS
G. VAN DER WAAL (Unichema, Netherlands) IN: Aviation gas turbine lubricants - Military and civil aspects: Aviation fuel and lubricants - Performance testing; Proceedings of the Aerospace Technology Conference and Exposition, Long Beach, CA, October 14-17, 1985 . Warrendale, PA, Society of Automotive Engineers, Inc., 1985, p. 109-114.
(SAE PAPER 851868)

To ensure the flawless performance of gasturbine engines it is essential to have a full understanding of the influence of ester base fluids on elastomers, which are used as seals in these engines. This paper describes the development of a simple model to relate the chemical structure of ester base fluids and elastomer swell properties. It's validity has been checked experimentally using a variety of elastomer seals and lubricant base fluids. This model offers a guideline in the selection of esters for gasturbine engine oils, enabling current or new military and civilian specifications to be met. Author

A86-38536
DEPOSITION IN GAS TURBINE OIL SYSTEMS. I - ANALYSIS AND CLASSIFICATION
D. G. DOWSE (Rolls-Royce, Ltd., Derby, England), E. JANSTEN (DFVLR, Cologne, West Germany), and K. MAIER (MTU Motoren- und Turbinen-Union Muenchen GmbH, Munich, West Germany) IN: Aviation gas turbine lubricants - Military and civil aspects: Aviation fuel and lubricants - Performance testing; Proceedings of the Aerospace Technology Conference and Exposition, Long Beach, CA, October 14-17, 1985 . Warrendale, PA, Society of Automotive Engineers, Inc., 1985, p. 115-131.
(SAE PAPER 851869)

Synthetic lubricants operating in today's gas turbine engines are often working to their limits in respect to thermal stability. Breakdown of these oils causes the formation of deposits in different areas of the engine oil system. Before action can be taken to minimize the deposition technology by either changes to formulation or design consideration it is important that the true nature of the deposit is examined. The results of an investigation of deposits taken from laboratory tests and engine environments are presented. These studies, conducted in a joint venture by the authors, attempt to characterize and classify the deposits in terms of their physical and chemical nature. Author

A86-38538
THE INFLUENCE OF JFTOT OPERATING PARAMETERS ON THE ASSESSMENT OF FUEL THERMAL STABILITY
D. R. KENDALL and J. S. MILLS (Shell Research, Ltd., Thornton Research Centre, Chester, England) IN: Aviation gas turbine lubricants - Military and civil aspects: Aviation fuel and lubricants - Performance testing; Proceedings of the Aerospace Technology Conference and Exposition, Long Beach, CA, October 14-17, 1985 . Warrendale, PA, Society of Automotive Engineers, Inc., 1985, p. 143-151. refs
(SAE PAPER 851871)

The performance of fuels in the Jet Fuel Thermal Oxidation Tester (JFTOT) has been compared with that in a simulated engine oil cooler. In an attempt to improve the poor correlation found between these tests, a carbon burn-off method has been developed to quantify the extent of deposition in the JFTOT and has been used to examine the influence of JFTOT operating conditions on fuel performance. This has shown that the poor correlation between the tests may be due to the low fuel flow rate and the use of aluminium (rather than stainless steel) test specimens in the standard JFTOT. Author

A86-38539
EVALUATION OF JFTOT TUBE DEPOSITS BY CARBON BURNOFF
G. DATSCHEFSKI (ESSO Research Centre, Abingdon, England) and T. G. R. FARTHING (Rolls-Royce, Ltd., Bristol, England) IN: Aviation gas turbine lubricants - Military and civil aspects: Aviation fuel and lubricants - Performance testing; Proceedings of the Aerospace Technology Conference and Exposition, Long Beach, CA, October 14-17, 1985 . Warrendale, PA, Society of Automotive Engineers, Inc., 1985, p. 153-158. Research supported by the Ministry of Defence (Procurement Executive). refs
(SAE PAPER 851994)

The Jet Fuel Thermal Oxidation Tester (JFTOT) is universally used to measure high temperature stability of aviation turbine fuels, which are pass or fail rated according to the amount of deposit formed on the heater tube, assessed by an optical reflectance method. A new quantitative tube rating method has been developed, in which the weight of deposit is determined by carbon burnoff. When applied to a series of test fuels, reasonable repeatability of results was obtained; it was also found that the magnitude of deposits at a given temperature varied with the type of fuel under test. Author

A86-38822#
INGOT METALLURGY ALUMINUM - LITHIUM ALLOYS FOR AIRCRAFT STRUCTURE
J. C. EKVALL and D. J. CHELLMAN (Lockheed-California Co., Burbank) IN: Structures, Structural Dynamics and Materials Conference, 27th, San Antonio, TX, May 19-21, 1986, Technical Papers. Part 1 . New York, American Institute of Aeronautics and Astronautics, 1986, p. 203-209. refs
(AIAA PAPER 86-0890)
Material property and structural tests were performed on Lockalite (Al-2.1Li-2.5Cu-1.0Mg-0.13Zr) and two Al-Li-X commercial alloy samples, and the results are compared with the properties of 7075-T6X aluminum. The structural behavior was demonstrated by static tests conducted on tapered lugs, typical of those used in airframe applications. An analysis of failure mode criteria shows potential weight savings of 7 to 17 percent for individual Al-Li aircraft structural components and 9.5 percent for a fighter aircraft. It is concluded that Lockalite represents a suitable replacement for conventional 7075-T6X aluminum alloys. I.S.

A86-38841#
COMPOSITE MATERIAL SERVICE EXPERIENCE ON BOEING COMMERCIAL AIRPLANES
R. L. COGGESHALL (Boeing Commercial Airplane Co., Seattle, WA) IN: Structures, Structural Dynamics and Materials Conference, 27th, San Antonio, TX, May 19-21, 1986, Technical Papers. Part 1 . New York, American Institute of Aeronautics and Astronautics, 1986, p. 366-369.
(AIAA PAPER 86-0947)
The results of the NASA-sponsored flight evaluation program assessing the serviceability and the repair history of composite structures and parts installed on Boeing commercial aircraft are discussed. Typical composite applications include boron-epoxy foreflaps in B707, the B737 graphite spoiler, and the honeycomb sandwich panel of the B727 elevators. Graphite, Kevlar, and graphite-Kevlar composites are included in all flight control surfaces, fixed panels, and fairings in the B757, B767, and B737-300 latest generation aircraft. Concurrent with the design of these components, inspection, and repair requirements and procedures were developed to cover service-induced damage.
I.S.

A86-38859#
EFFECT OF CRACK GROWTH RATE VARIATIONS ON LIFE PREDICTIONS
R. L. WILKINSON (USAF, Armament Div., Eglin AFB, FL) and R. M. ENGLE, JR. (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) IN: Structures, Structural Dynamics and Materials Conference, 27th, San Antonio, TX, May 19-21, 1986, Technical Papers. Part 1 . New York, American Institute of Aeronautics and Astronautics, 1986, p. 551-561. refs
(AIAA PAPER 86-0981)
In this paper, data from sixty-eight panels of 2024-T3 aluminum, all tested to identical conditions, were analyzed using the Walker equation to determine the statistical distribution of the crack growth rate constants, 'C' and 'N'. Using this analysis as a model of material property variation, fifteen combinations of maximum load and sequence were selected, and life predictions were made for each of twelve selections from the material properties distributions. Distributions of crack growth lives were determined, and the mean values were found to agree with a baseline deterministic life prediction within five percent. A regression analysis was also performed to determine life as a function of stress level and 'N' for the entire simulation of 180 trials. Agreement with the mean predicted lives was within 13 percent. Author

A86-39617
FATIGUE BEHAVIOR OF TI-6AL-4V POWDER METALLURGY COMPACTS
F. H. FROES, S. W. SCHWENKER (USAF, Materials Laboratory, Wright-Patterson AFB, OH), and D. EYLON (Metcut Research Associates, Inc., Metcut-Materials Research Group, Wright-Patterson AFB, OH) IN: 1985 Annual Powder Metallurgy Conference, San Francisco, CA, July 14-17, 1985, Proceedings . Princeton, NJ, Metal Powder Industries Federation, 1986, p. 519-530. refs
(Contract F33615-82-C-5078)
Good fatigue behavior is a major requirement for increased use of PM titanium components in airframe and gas turbine engine applications. The factors necessary to improve fatigue for both blended elemental (BE) and prealloyed (PA) components are discussed. In BE material the primary concern is to lower the level of salt contamination. For PA components, a low level of general contaminants, below the 50 micron level, is required. Recent work on microstructural modification in titanium PM material has resulted in fatigue strength superior to annealed ingot metallurgy products. These microstructure modifications have been achieved by either direct heat treatment or by thermochemical treatment, using hydrogen as a temporary alloying element.
Author

N86-26384# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.
EVALUATION OF THE EFFECTS OF A PLASTIC BEAD PAINT REMOVAL PROCESS ON PROPERTIES OF AIRCRAFT STRUCTURAL MATERIALS Final Report, Oct. 1984 - Aug. 1985
S. CHILDERS, D. C. WATSON, P. STUMPFF, and J. TIRPAK Dec. 1985 151 p
(AD-A165289; AD-F630715; AFWAL-TR-85-4138) Avail: NTIS HC A08/MF A01 CSCL 11D
An abrasive blasting process using plastic beads has been proposed for removing organic coatings from aircraft surfaces and component parts. During the prototype development of the plastic bead blasting process for paint removal many concerns surfaced relative to the potential effects of the process on metal and composite aircraft structural materials. This evaluation of the plastic bead blasting paint removal showed that it removed protective metal coatings such as aluminum cladding and anodize coatings from aluminum alloys and cadmium plating from steel structure. Surface roughness resulted on clad aluminum alloys. Warpage as a result of surface cold working occurred on unsupported thin skin metal materials. The bond strength of thin skin adhesive bonded structure was not affected. The process is less damaging in fatigue to 7075-T6 aluminum structure blasted at 60 psi nozzle pressure than at 38 psi nozzle pressure. Epoxy/graphite composite structure which was plastic bead blasted showed statistically significant losses in the matrix dominated properties. No significant reductions occurred in the fiber dominated mechanical properties.
GRA

N86-26429# National Aerospace Lab., Amsterdam (Netherlands). Structures and Materials Div.
ENGINEERING PROPERTY COMPARISONS FOR 2324-T39 AND 2024-T351 ALUMINUM ALLOY PLATE
L. SCHRA and W. G. J. THART 19 Mar. 1984 64 p
(Contract NIVR-1906)
(NLR-TR-84021-U; B8576225; ESA-86-96979) Avail: NTIS HC A04/MF A01
Engineering properties of the plate material of aluminum alloy 2324-T39 and alloy 2024-T351 were compared. Tensile strength, fracture toughness, notched fatigue strength, and the resistance to fatigue crack propagation under constant amplitude and flight simulation loading were considered. Significantly higher strength and fracture toughness properties are found for 2324-T39, but the notched fatigue strengths of both alloys are comparable. Fatigue crack propagation resistance of 2324-T39 is slightly better than 2024-T351 under constant amplitude loading, but less resistant under flight simulation loading. The latter result indicates that

replacement of 2024-T351 by 2324-T39 in fatigue critical areas is questionable. ESA

N86-26430# National Aerospace Lab., Amsterdam (Netherlands). Structures and Materials Div.

EFFECTS OF CLADDING AND ANODIZING ON FLIGHT SIMULATION FATIGUE OF 2024-T3 AND 7475-T761 ALUMINUM ALLOYS

R. J. H. WANHILL Jan. 1985 29 p refs
(Contract NIVR-1891)
(NLR-TR-85006-U; B8578427; ESA-86-96984) Avail: NTIS HC A03/MF A01

The effects of cladding and anodizing on flight simulation (gust spectrum) fatigue of notch specimens and riveted lap joints of 2024-T3 and 7475-T761 aluminum alloy sheet were investigated. Stress levels were chosen to provide long life data (100,000 simulated flights) for bare alloy specimens. Cladding and anodizing have very large effects on the fatigue lives. Cladding and anodizing are always detrimental for notched specimens. For lap joints, cladding is detrimental only combined with anodizing. Anodizing is very beneficial for lap joints to be assembled from bare alloy sheets. With equivalent surface treatments 2024-T3 specimens always have longer average fatigue lives than 7475-T761 specimens. ESA

N86-26446# Southwest Research Inst., San Antonio, Tex. Fuels and Lubricants Research Facility.

HIGH-TEMPERATURE LUBRICATION SYSTEMS FOR RING/LINER APPLICATIONS IN ADVANCED HEAT ENGINES Interim Report, Oct. 1984 - Jul. 1985

M. D. KANAKIA, E. C. OWENS, and M. B. PETERSON Jul. 1985 66 p Prepared in cooperation with Wear Sciences, Inc., Arnold, Md.
(Contract DAAK70-82-C-0001; DAAK70-85-C-0007)
(AD-A164955; BFLRF-189) Avail: NTIS HC A04/MF A01 CSCL 11H

An assessment of tribological requirements in upper cylinder area of advanced high temperature engines was made in terms of critical components and their operating conditions. The ring-liner applications are the most severe since they have high temperature (<800 F) and large number of sliding cycles 10 to the 8th power - 10 to the 10th power. This report explores and evaluates various high temperature tribological systems lubricants, materials and lubricant delivery or supply systems for high temperature ring-liner applications. Author (GRA)

N86-27425# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Structures and Materials Panel.

IMPACT DAMAGE TO COMPOSITE STRUCTURES

Feb. 1986 40 p
(AGARD-R-729; ISBN-92-835-1517-X) Avail: NTIS HC A03/MF A01

The impact of ballistic penetrators in fuel filled tanks generates high dynamic pressure loading. This damage process is generally referred to as hydraulic ram. Hydraulic ram in aircraft fuel tanks results in large damage of structural components, which in turn can lead to fuel loss or ingestion into the engines, fire and explosion. To determine the effect of hydraulic ram to an integral fuselage fuel tank with carbon/epoxy skin, a firing program was established. Plane carbon/epoxy plates, bolted to an impact box, were impacted with single cuboid fragments. Different shock-absorbing materials used to reduce hydraulic ram pressures on the impact plate, were investigated to prevent propagation of the shock wave. Multiple fragments were projected against the simulated fuel tank sections with carbon/epoxy skins and sandwich design at a hit density of 25 fragments per square meter. Author

N86-27457# Department of the Navy, Washington, D. C.

NONSKID COATING FORMULATIONS Patent Application

L. W. KRAFT and R. F. BRADY, inventors (to Navy) 22 Jan. 1986 15 p
(AD-D012186; US-PATENT-APPL-SN-621308) Avail: NTIS HC A02/MF A01 CSCL 01E

It is an object of the present invention to provide improved nonskid coating formulations having enhanced impact resistance and resistance to sliding movement thereon by aircraft or other equipment. It is a further object of the invention to provide nonskid coatings which will maintain their adhesion to primed steel after severe impact and thus eliminate the hazards caused by dislodged fragments. Yet another object of the invention is to provide nonskid coatings which are resistant to wear and which provide resistance to sliding throughout their service life by virtue of their coarse textured surface. The nonskid coating formulations of the present invention are comprised of two or more components that contain specified ingredients in specified amounts. The nonskid coating formulation is comprised of the following ingredients, by weight, 3 to 8% amine resins, 7 to 13% epoxy resins, 17 to 22% pigments, fillers, and thickeners, 10 to 20% solvents and 39 to 56% aggregates. GRA

N86-27461# Monsanto Co., Dayton, Ohio.

PROPERTIES OF AIRCRAFT FUELS AND RELATED MATERIALS Final Report, 15 Feb. 1982 - 31 Jan. 1985

D. S. DUVALL, A. D. SNYDER, J. HENRY, D. J. LEWIS, and F. N. HODGSON Aug. 1985 162 p
(Contract F33615-81-C-2035)
(AD-A164532; AFWAL-TR-85-2049) Avail: NTIS HC A08/MF A01 CSCL 21D

Fuel tests, analyses, and analytical method development were conducted on a number of fuels of an experimental nature in conjuction with ongoing Air Force programs for studying fuel combustion behavior, turbine engine design, and other fuel related technologies. Fuels from conventional and alternate sources were studied, as were fuels of the high density missile propellant type. A wide variety of both physical and chemical properties of the fuels were measured and are tabulated. Studies conducted to aid in the solution of operational problems are also reported. GRA

N86-27465# Du Pont de Nemours (E. I.) and Co., Aiken, S.C. Savannah River Lab.

MULTISTAGE METAL HYDRIDE COMPRESSOR

L. K. HEUNG 1986 14 p Presented at the Solid Storage Science and Engineering Meeting, Los Alamos, N. Mex., 12 Mar. 1986
(Contract DE-AC09-76SR-00001)
(DE86-001965; DP-MS-85-83; CONF-860345-1) Avail: NTIS HC A02/MF A01

Metal hydride compressors can compress hydrogen to high pressures without using mechanical moving parts. They are particularly suited for tritium applications because they require minimal maintenance. A three-stage metal hydride compressor which can compress hydrogen from 14.7 to 20,000 psia has been demonstrated. The design principle and experimental results are presented. DOE

12

ENGINEERING

Includes engineering (general); communications; electronics and electrical engineering; fluid mechanics and heat transfer; instrumentation and photography; lasers and masers; mechanical engineering; quality assurance and reliability; and structural mechanics.

A86-37323
HOW US COMPANIES ARE ATTACKING PRODUCTION COSTS
P. TURK Interavia (ISSN 0020-5168), vol. 41, April 1986, p. 419-423.

A comparative evaluation is made of the manufacturing costs-reduction impact of state-of-the-art aircraft materials and fabrication processes which combine automation with highly flexible process-control software. The techniques in question encompass both organic-matrix composites and novel metallic compositions; many have already been successfully applied in the construction of high performance military aircraft. Attention is given to the 'stealth technology'-related advantages of the novel automated fabrication technologies, and the most consequential characteristics of thermoplastic-matrix composites. O.C.

A86-37348#
THE DYNAMIC INSTABILITY OF PLATE STRUCTURES
H.-J. LIN and Y.-J. LEE (National Taiwan University, Taipei, Republic of China) Chinese Institute of Engineers, Journal (ISSN 0253-3839), vol. 9, Jan. 1986, p. 59-67. refs

The instability of plate structures subjected to in-plane periodic forces (e.g., buckling of ship decks and flat aircraft structures by winds storms) is analyzed using the finite element method. In the analysis, the mass matrix and the geometric stiffness matrix are introduced, and shear effects are taken into consideration. The eight-node isoparametric plate element and the three-node isoparametric beam element are applied in the analysis of regions of dynamic instability for plate, plate with a hole, stiffened plate, and beam. I.S.

A86-37406#
VIBRATION TEST AND IDENTIFICATION OF MODAL PARAMETER OF AIRCRAFT WING MODEL
Z. LI, Q. ZENG, and Z. WU Northwestern Polytechnical University, Journal, vol. 4, April 1986, p. 189-198. In Chinese, with abstract in English. refs

A value of 1 is assumed as the constant term in the denominator polynomial of a curve fitting rational-function polynomial and and employed to perform modal analysis of a scale model wing undergoing flutter. Experimental data were obtained by means of a vibration test featuring periodic, random signal excitation in a low speed wind tunnel. The experimental data were used to derive the frequency response function at 82 nodes. The analysis indicated that the coherence function approaches unity at frequencies near resonance. Sample data are provided from a determination of the vibration modes of two components of the wing model. The modes are shown to be in good agreement with those obtained with finite element method. M.S.K.

A86-38224
RADAR DATA PROCESSING. VOLUME 2 - ADVANCED TOPICS AND APPLICATIONS
A. FARINA and F. A. STUDER (Selenia S.p.A., Rome, Italy) Letchworth, England/New York, Research Studies Press, Ltd./John Wiley and Sons, Inc. (Electronic and Electrical Engineering Research Studies: Electronic Circuits and Systems Series, No. 3), 1986, 356 p. refs

The design and implementation of the radar data processing (RDP) theory are discussed. Data processing for netted monostatic and bistatic radar systems and technical problems such as the misalignment between radars and target altitude uncertainty are examined. The organization and display of the data on a computer system are studied. The computer simulation of tracking algorithms for RDP performance evaluation and the application of the simulation technique to monoradar and multiradar tracking algorithms are analyzed. The use of RDP in air-traffic control systems, maritime navigation surveillance, and defense systems is investigated. Computer requirements for the implementation of RDP algorithms are described. I.F.

A86-38235* High Technology Corp., Hampton, Va.
COMPARISON OF HOT-WIRE MEASUREMENT TECHNIQUES IN A MACH 3 PILOT QUIET TUNNEL
F.-J. CHEN (High Technology Corp., Hampton, VA) and I. E. BECKWITH (NASA, Langley Research Center, Hampton, VA) IN: ICIASF '85 - International Congress on Instrumentation in Aerospace Simulation Facilities, 11th, Stanford, CA, August 26-28, 1985, Record . New York, Institute of Electrical and Electronics Engineers, 1985, p. 79-85. refs

Disturbance measurements were made in the free stream of a small Mach 3 quiet tunnel using constant-current and constant-temperature anemometers (CCA and CTA). Data from the two types of instruments are compared in terms of frequency response and normalized rms levels of mass flow fluctuations. The mode-diagram analysis of the CCA data produces reliable results because the frequency response is consistent for a wide range of overheat ratios. However, the mode-diagram results for the CTA data cannot be used due to the rapidly decreasing frequency response with decreasing overheat ratio. Only the mass flow fluctuations at high overheat ratio can be obtained with the CTA system, and they can be as much as 50 percent higher than those from the CCA system. Possible reasons for these measurement differences between the two systems are considered. Author

A86-38236*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.
DEVELOPMENT OF A TEMPERATURE-COMPENSATED HOT-FILM ANEMOMETER SYSTEM FOR BOUNDARY-LAYER TRANSITION DETECTION ON HIGH-PERFORMANCE AIRCRAFT
H. R. CHILES and J. B. JOHNSON (NASA, Flight Research Center, Edwards, CA) IN: ICIASF '85 - International Congress on Instrumentation in Aerospace Simulation Facilities, 11th, Stanford, CA, August 26-28, 1985, Record . New York, Institute of Electrical and Electronics Engineers, 1985, p. 86-91. Previously announced in STAR as N85-33121.

A hot-film constant-temperature anemometer (CTA) system was flight-tested and evaluated as a candidate sensor for determining boundary-layer transition on high-performance aircraft. The hot-film gage withstood an extreme flow environment characterized by shock waves and high dynamic pressures, although sensitivity to the local total temperature with the CTA indicated the need for some form of temperature compensation. A temperature-compensation scheme was developed and two CTAs were modified and flight-tested on the F-104/Flight Test Fixture (FTF) facility at a variety of Mach numbers and altitudes, ranging from 0.4 to 1.8 and 5,000 to 40,000 ft respectively. Author

A86-38237
PULSED LASER LIGHT SHEET FLOW VISUALIZATION
D. C. SOREIDE, G. D. DOUGLAS, and W. P. BRANDT (Boeing Commercial Airplane Co., Seattle, WA) IN: ICIASF '85 - International Congress on Instrumentation in Aerospace Simulation Facilities, 11th, Stanford, CA, August 26-28, 1985, Record . New York, Institute of Electrical and Electronics Engineers, 1985, p. 100-105.

A pulsed ruby laser was used as light source for a set of flow visualization tests involving two test situations. In both cases, the conducted investigation was concerned with the location of the tip vortex of the rotor-blade of a helicopter, giving particular attention to the position relative to the following blade. The optical system employed is considered along with the electronics system, the setup equipment, and the helicopter test. Vortex field maps

are provided for the case in which the helicopter rotor vortex field phase angle equals 0 degrees and for the case in which this angle equals 90 degrees. G.R.

A86-38310* AiResearch Casting Co., Torrance, Calif.
FABRICATION OF CERAMIC COMPONENTS FOR ADVANCED GAS TURBINE ENGINES
F. LIU and E. SOLIDUM (AiResearch Casting Co., Torrance, CA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 12 p. DOE-sponsored research. refs
(Contract DEN3-167)
(SAE PAPER 851786)

The AGT101 ceramic gas turbine engine feasibility study has made use of the slip casting of silicon or silicon nitride powders to produce either reaction-bonded or sintered components such as turbine rotors, turbine shrouds, and inner and outer diffusers. Attention is given to the effects of processing parameters on the microstructure and properties of the finished components; the parameters encompass powder particle size distribution, casting slip viscosity, pH, and solid content fraction. The green slip cast components were consolidated by nitriding, sintering, or sinter/HIPping. O.C.

A86-38311* AiResearch Casting Co., Torrance, Calif.
PROCESSING STUDY OF INJECTION MOLDING OF SILICON NITRIDE FOR ENGINE APPLICATIONS
M. E. RORABAUGH and H. C. YEH (AiResarch Casting Co., Torrance, CA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 7 p.
(Contract NAS3-24385)
(SAE PAPER 851787)

The high hardness of silicon nitride, which is currently under consideration as a structural material for such hot engine components as turbine blades, renders machining of the material prohibitively costly; the near net shape forming technique of injection molding is accordingly favored as a means for component fabrication. Attention is presently given to the relationships between injection molding processing parameters and the resulting microstructural and mechanical properties of the resulting engine parts. An experimental program has been conducted under NASA sponsorship which tests the quality of injection molded bars of silicon nitride at various stages of processing. O.C.

A86-38318
MECHANICAL INTERFACE DEVICES FOR AUTOMATIC TEST EQUIPMENT
T. R. HESSEL (Grumman Corp., Bethpage, NY) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 8 p.
(SAE PAPER 851795)

This paper discusses interfaces to Automatic Test Equipment (ATE) for two engineering disciplines, optics and fluids. A detailed description of the development of an optical test port for ATE shows how this device functions with ATE to support a television tracking system. A description of a fluids interface highlights the diverse requirements for automatic testing. Author

A86-38320
FLEXIBLE MANUFACTURING SYSTEM FOR THE FABRICATION OF PRECISION COMPONENTS WITH REAL TIME SIMULATION
H. R. GRAF (Hughes Aircraft Co., El Segundo, CA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 7 p.
(SAE PAPER 851804)

Real-time simulation for manufacturing decision support will soon become critical to the operation of flexible manufacturing systems. On unmanned systems, where many dissimilar parts are machined in random lot sizes to a high degree of precision, it is essential that the simulation model be continually updated by the system on the status of the product flowing through the system, as well as the status of equipment in the system. Real-time simulation will be a critical element in future computer integrated manufacturing systems. Author

A86-38321
PROCESS FOR ADHESIVE BONDING OF METAL SKINS TO AIRCRAFT STRUCTURES
P. M. PHILLIPS (Murdock Engineering Co., Irving, TX) and S. C. AKER SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 9 p. refs
(SAE PAPER 851805)

A manufacturing process for the production of an adhesive bonded wet wing structure is described. The process involves: (1) the development of a laminated wing skins with bonded stringers subassembly; (2) the development of laminated skin to spar and rib subassembly; and (3) the bonding of the upper and lower skins. The advantages of bonded structures, which include lower weight, longer service life, and lower maintenance costs, are discussed. The surface preparation, adhesive films, and quality control for wing bonded structures are examined. The cost-effectiveness of bonded structures is analyzed. I.F.

A86-38335* Douglas Aircraft Co., Inc., Long Beach, Calif.
THE DESIGN OF REPAIRABLE ADVANCED COMPOSITE STRUCTURES
L. J. HART-SMITH (Douglas Aircraft Co., Long Beach, CA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 17 p. refs
(Contract NAS1-11234; NAS1-13172; NAS1-16857; F33615-79-C-3212; F33615-80-C-5092)
(SAE PAPER 851830)

This paper addresses the repair of advanced composite structures by mechanical fasteners or by adhesive bonding. It is shown that many of today's composite designs are unreasonably difficult to repair. Conversely, the knowledge to design repairable structures is already available, if only it is applied during the initial design stage. Bolted or riveted repairs require only the avoidance of extremely orthotropic composite fiber patterns; those near the quasi-isotropic layup are the most suitable. Mildly orthotropic fiber patterns are appropriate for structures in which there is a dominant load direction. Thick composite structures are shown to require bolted or riveted repairs while thin structures favor adhesively bonded permanent repairs, although provisions can be easily made for temporary mechanical repairs. The reasons why integrally stiffened cocured composite designs are usually impractical to repair are explained and alternative repairable design concepts are presented. Author

A86-38358
WAKE IMAGING SYSTEM APPLICATIONS AT THE BOEING AERODYNAMICS LABORATORY
O. P. CROWDER (Boeing Commercial Airplane Co., Seattle, WA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 17 p. refs
(SAE PAPER 851895)

The wake imaging system (WIS) for rapid mappings of wind-tunnel model flowfields is described and a summary of recent results is presented. Three different types of systems are discussed. These are: (1) photographic WIS in low-speed wind tunnels, (2) computer graphics WIS in transonic wind tunnels, and (3) flying-strut traverser for large low-speed wind tunnels. In addition, progress toward developing a low intrusive WIS for high-pressure transonic wind tunnels and for flight test applications is described. Author

A86-38522
A CEMENTITIOUS TOOLING/MOLDING MATERIAL - ROOM TEMPERATURE CASTABLE, HIGH TEMPERATURE CAPABLE
S. WISE and S. KUO IN: Composites: Design and manufacturing for general aviation aircraft; Proceedings of the General Aviation Aircraft Meeting and Exposition, Wichita, KS, April 16-19, 1985 . Warrendale, PA, Society of Automotive Engineers, Inc., 1985, p. 61-66.
(SAE PAPER 850904)

Dash 47R is a cementitious composite initially formulated for use as an autoclave molding/tooling material. A unique matrix and aggregate system imparts unusually high strength and excellent vacuum integrity to DASH 47 at moderately high temperatures even though DASH 47 molds are cast at ambient temperature over commonly used pattern materials. This paper reviews the formulation and properties of DASH 47, and outlines its fabrication method and curing schedule for thin-shelled autoclave tools. In addition, examples of other molding applications for DASH 47 are shown in this paper. Author

A86-38523
GENERATION OF AN ELECTROFORMED NICKEL MOLD FOR USE IN MANUFACTURING COMPOSITE PARTS
D. L. SHELDON IN: Composites: Design and manufacturing for general aviation aircraft; Proceedings of the General Aviation Aircraft Meeting and Exposition, Wichita, KS, April 16-19, 1985 . Warrendale, PA, Society of Automotive Engineers, Inc., 1985, p. 67-69.
(SAE PAPER 850905)

Attention is given to the fabrication of electroformed nickel tools for use in the manufacture of composite parts, as well as the techniques used in the development of tools of this type. The method involves the electrodeposition of a metal onto a cathodic mandrel; the electrode is connected to a positive pole, while the mandrel is connected to the negative pole of a dc source. Two molds have been formed in this way for the wings of the AV-8B Harrier VTOL aircraft, representing the upper and lower wing contours. O.C.

A86-38526
AVIATION GAS TURBINE LUBRICANTS - MILITARY AND CIVIL ASPECTS: AVIATION FUEL AND LUBRICANTS - PERFORMANCE TESTING; PROCEEDINGS OF THE AEROSPACE TECHNOLOGY CONFERENCE AND EXPOSITION, LONG BEACH, CA, OCTOBER 14-17, 1985
Conference and Exposition sponsored by SAE. Warrendale, PA, Society of Automotive Engineers, Inc. (SAE SP-633), 1985, 163 p. For individual items see A86-38527 to A86-38539.
(SAE SP-633)

Research and development programs in the areas of gas turbine lubricants for civil and military aviation and the performance testing of aviation gas turbine fuels and lubricants are discussed. The topics addressed include: laboratory and field evaluation of a high temperature jet engine oil, performance advantages of high load aviation lubricants, fluorocarbon elastomer compatibility with gas turbine lubricants, potential benefits in the development of a dedicated helicopter transmission lubricant, and feasibility of formulating advanced four centistoke gas turbine oils. Also covered are: advanced lubricants for aircraft turbine engines, future trends for U.S. Naval aviation propulsion system lubricants, electrochemical evaluation of corrosivity in turbine engine oils, the influence of esters on elastomer seals, deposition in gas turbine oil systems, development of the portable water separometer for the WSIM test, influence of JFTOT operating parameters on the assessment of fuel thermal stability, and evaluation of JFTOT tube deposits by carbon burnoff. C.D.

A86-38527
DEVELOPMENT OF A HIGH TEMPERATURE JET ENGINE OIL - LABORATORY AND FIELD EVALUATION
H. L. HEPPLEWHITE, W. H. BUCK (Mobil Research and Development Corp., Paulsboro, NJ), and F. FEINBERG (Mobil Oil Corp., U.S. Marketing and Refining Div., Fairfax, VA) IN: Aviation gas turbine lubricants - Military and civil aspects: Aviation fuel and lubricants - Performance testing; Proceedings of the Aerospace Technology Conference and Exposition, Long Beach, CA, October 14-17, 1985 . Warrendale, PA, Society of Automotive Engineers, Inc., 1985, p. 1-17.
(SAE PAPER 851797)

Laboratory oxidation tests used to evaluate jet engine oils for stability and deposit control in several physical configurations are described. The use of these tests to formulate a new oil with enhanced capabilities at high temperatures is reported along with field evaluations which show performance benefits consistent with laboratory test results. A particular improvement has occurred in the number of oil-related engine removals. Additional improvements reported include cleaner engines, resulting in increased reliability of carbon seals, reduced oil consumption, improved engine reliability, and reduced maintenance. The results show that the laboratory tests can accurately discriminate among oils in terms of performance capability. C.D.

A86-38528
PERFORMANCE ADVANTAGES OF HIGH LOAD AVIATION LUBRICANTS
D. S. BOSNIACK (Exxon Research and Engineering Co., Products Research Div., Annandale, NJ) and S. J. METRO IN: Aviation gas turbine lubricants - Military and civil aspects: Aviation fuel and lubricants - Performance testing; Proceedings of the Aerospace Technology Conference and Exposition, Long Beach, CA, October 14-17, 1985 . Warrendale, PA, Society of Automotive Engineers, Inc., 1985, p. 19-32.
(SAE PAPER 851798)

Aviation lubricants were extensively tested at severe conditions to determine the performance advantages of incorporating a load carrying additive. A high load oil performed at least as well or better than a normal load oil in the bearing rig test at Type 1 through Type 2-1/2 conditions. At the extremely severe Type 2-3/4 conditions, in an inerted atmosphere, all oils tested containing load carrying additives successfully completed the 100-hour test, while all oils tested without the additive suffered catastrophic failure in less than 10 hours. The role of the load carring additive in the protection of loaded, moving parts, as in the Ryder Gear Machine, was examined. Data for the anti-scuffing protection afforded by this additive through surface adsorption on working gears is presented. Author

A86-38530
A STUDY OF THE POTENTIAL BENEFITS ASSOCIATED WITH THE DEVELOPMENT OF A DEDICATED HELICOPTER TRANSMISSION LUBRICANT
R. J. DRAGO (Boeing Vertol Co., Philadelphia, PA), P. J. MANGIONE, and R. D. WENDRZYCKI (U.S. Navy, Naval Air Propulsion Test Center, Trenton, NJ) IN: Aviation gas turbine lubricants - Military and civil aspects: Aviation fuel and lubricants - Performance testing; Proceedings of the Aerospace Technology Conference and Exposition, Long Beach, CA, October 14-17, 1985 . Warrendale, PA, Society of Automotive Engineers, Inc., 1985, p. 59-68.
(SAE PAPER 851832)

A common oil is now used in both the engines and transmissions of virtually all U.S. military helicopters. While this provides significant logistic advantages, these advantages are attained only by compromising the optimization of the oil for either system. The results of two studies undertaken to determine what benefits would accrue to the development of a special oil tailored specifically to meet the unique requirements of high-speed, heavily loaded helicopter transmission systems are presented. These studies, conducted independently by two major helicopter manufacturers under the direction of the Naval Air Propulsion Center, addressed

specific problem areas related to typical production aircraft in order to reach well-documented conclusions. In addition, the effect of the availability of such a special gear-box lubricant on the development of other advanced-technology components was evaluated and documented. Author

A86-38533
FUTURE TRENDS FOR U.S. NAVAL AVIATION PROPULSION SYSTEM LUBRICANTS
J. T. SHIMSKI and L. A. PASKOW (U.S. Navy, Naval Air Propulsion Test Center, Trenton, NJ) IN: Aviation gas turbine lubricants - Military and civil aspects: Aviation fuel and lubricants - Performance testing; Proceedings of the Aerospace Technology Conference and Exposition, Long Beach, CA, October 14-17, 1985 . Warrendale, PA, Society of Automotive Engineers, Inc., 1985, p. 95-102.
(SAE PAPER 851835)

Although present performance of aircraft gas turbine engine lubricants is satisfactory, two major areas have been targeted for improvement: static bearing corrosion and thermal stability of the oil. Trends in future engine designs indicate that waste heat rejection will be the limiting factor in the development of high temperature lubricants. Field experience has shown that present performance of aircraft gas turbine engine lubricants in helicopter gearbox systems is marginal. A three-phase program has been initiated to develop a separate lubricant with improved load-carrying capacity and corrosion inhibition. Future design requirements will have to incorporate new materials and lubricants concurrently. Author

A86-38537
DEVELOPMENT OF THE PORTABLE WATER SEPAROMETER FOR THE WSIM TEST
P. W. KIRKLIN (Mobil Research and Development Corp., Paulsboro, NJ), F. R. EDMONDSON (EMCEE Electronics, Inc., Sarasota, FL), F. P. MORSE (USAF, Directorate of Energy Management, Kelly AFB, TX), and W. G. DUKEK IN: Aviation gas turbine lubricants - Military and civil aspects: Aviation fuel and lubricants - Performance testing; Proceedings of the Aerospace Technology Conference and Exposition, Long Beach, CA, October 14-17, 1985 . Warrendale, PA, Society of Automotive Engineers, Inc., 1985, p. 133-141. refs
(SAE PAPER 851870)

The water separation index, modified (WSIM) test, ASTM D2550, is used to indicate the presence of harmful levels of surface active agents (surfactants) in jet fuel. Many fuel suppliers, handlers and users have replaced the complex laboratory test, ASTM D2550, with a quick, simple test, ASTM D3948, that uses a compact, portable field test instrument, the Micro-Separometer. Results of co-operative ASTM test programs to develop the Micro-Separometer test are presented. The report shows that the Micro-Separometer produces the same water separation index as ASTM D2550 and that the test precision is equivalent or better. Author

A86-38617*# North Carolina State Univ., Raleigh.
LINEAR DYNAMIC COUPLING IN GEARED ROTOR SYSTEMS
J. W. DAVID (North Carolina State University, Raleigh) and L. D. MITCHELL (Virginia Polytechnic Institute and State University, Blacksburg) ASME, Transactions, Journal of Vibration, Acoustics, Stress, and Reliability in Design (ISSN 0739-3717), vol. 108, April 1986, p. 171-176. refs
(Contract NSG-3239)
(ASME PAPER 85-DET-11)

The effects of high frequency oscillations caused by the gear mesh, on components of a geared system that can be modeled as rigid discs are analyzed using linear dynamic coupling terms. The coupled, nonlinear equations of motion for a disc attached to a rotating shaft are presented. The results of a trial problem analysis show that the inclusion of the linear dynamic coupling terms can produce significant changes in the predicted response of geared rotor systems, and that the produced sideband responses are greater than the unbalanced response. The method is useful in designing gear drives for heavy-lift helicopters, industrial speed reducers, naval propulsion systems, and heavy off-road equipment. I.S.

A86-38831#
BUCKLING AND FINAL FAILURE OF GRAPHITE/PEEK STIFFENER SECTIONS
S. M. CAUSBIE (Boeing Commerical Airplane Co., Seattle, WA) and P. A. LAGACE (MIT, Cambridge, MA) IN: Structures, Structural Dynamics and Materials Conference, 27th, San Antonio, TX, May 19-21, 1986, Technical Papers. Part 1 . New York, American Institute of Aeronautics and Astronautics, 1986, p. 280-287. refs
(AIAA PAPER 86-0921)

The buckling and final failure characteristics of laminated angle and channel stiffener sections made of APC-2 graphite/thermoplastic material which employs PEEK fibers were investigated. Three stacking sequences with the same ply orientations were used in the experimental studies, the results of which were compared with buckling loads and modes estimated by use of the Ritz technique. Both the theoretical and experimental results indicate that buckling load decreases as (1) the side boundary conditions of the critical stiffener element become less restrictive; (2) the effective width/thickness ratio of the critical stiffener element is increased; (3) the bending stiffness term decreases; and (4) the bending-twisting coupling terms increase. The experimental results are similar to those obtained for similar sections made from T300/5208 graphite/epoxy material. I.S.

A86-38833#
OBSERVATIONS ON COMPRESSIVE LOCAL BUCKLING, POSTBUCKLING AND CRIPPLING OF GRAPHITE/EPOXY AIRFRAME STRUCTURE
L. W. REHFIELD and A. D. REDDY (Georgia Institute of Technology, Atlanta) IN: Structures, Structural Dynamics and Materials Conference, 27th, San Antonio, TX, May 19-21, 1986, Technical Papers. Part 1 . New York, American Institute of Aeronautics and Astronautics, 1986, p. 301-306. Research supported by the United Technologies Corp. refs
(Contract DAAG29-82-K-0094)
(AIAA PAPER 86-0923)

Local buckling, postbuckling, and crippling of I-section composite specimens under axial compression were studied using high-speed photography. The specimens, representative of an airframe structure, were made of C3000/5225 graphite-epoxy woven cloth with five different web and flange ply layups. The results have shown that the critical failure mode is flange edge delamination followed by simultaneous failure of the flange and web. This finding implies that casual use of material strength criteria, without having a criterion for free edge delamination, may be misleading, and that multiple failure modes must be considered in order to reliably predict crippling. I.S.

A86-38853#
STRENGTH EVALUATION OF HELICOPTER COMPOSITE BOLTED JOINTS
S. P. GARBO, S. W. HONG, and W. KIM (United Technologies Corp., Sikorsky Aircraft Div., Stratford, CT) IN: Structures, Structural Dynamics and Materials Conference, 27th, San Antonio, TX, May 19-21, 1986, Technical Papers. Part 1 . New York, American Institute of Aeronautics and Astronautics, 1986, p. 486-494. refs
(AIAA PAPER 86-0973)

Preliminary results of an analytical and experimental evaluation of the strength of bolted joints of three different composite systems considered for helicopter applications are reported. The three systems, carbon/epoxy tape, carbon/epoxy fabric, and carbon/bismaleimide laminates, were tested to failure using open-hole and bolt-bearing configurations, and stress-strain analysis was carried out for various hole-size geometries and bearing-bypass load conditions. Initial theory/test correlations successfully verified predicted failure modes and location of failure. Open-hole failure load predictions were used to establish a candidate characteristic dimension which was used to predict preliminary bypass vs bearing strength envelopes for the three

material systems. For the application geometries tested, no significant differences in solutions due to geometry effects were determined. V.L.

A86-38857*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.

BUCKLING BEHAVIOR OF RENE 41 TUBULAR PANELS FOR A HYPERSONIC AIRCRAFT WING

W. L. KO, R. A. FIELDS (NASA, Flight Research Center, Edwards, CA), and J. L. SHIDELER (NASA, Langley Research Center, Hampton, VA) IN: Structures, Structural Dynamics and Materials Conference, 27th, San Antonio, TX, May 19-21, 1986, Technical Papers. Part 1 . New York, American Institute of Aeronautics and Astronautics, 1986, p. 517-544. refs
(AIAA PAPER 86-0978)

The buckling characteristics of Rene 41 tubular panels for a hypersonic aircraft wing were investigated. The panels were repeatedly tested for buckling characteristics using a hypersonic wing test structure and a universal tension/compression testing machine. The nondestructive buckling tests were carried out under different combined load conditions and in different temperature environments. The force/stiffness technique was used to determine the buckling loads of the panels. In spite of some data scattering resulting from large extrapolations of the data-fitting curve (because of the termination of applied loads at relatively low percentages of the buckling loads), the overall test data correlate fairly well with theoretically predicted buckling interaction curves. Also, the structural efficiency of the tubular panels was found to be slightly higher than that of beaded panels. Author

A86-38876#

APPLICATION OF LOW TEMPERATURE CURING PREPREGS AND VACUUM BAG MOLDING TECHNIQUES TO THE MANUFACTURING OF A COMPOSITE WING

E. AHOPELTO (Helsinki University of Technology, Espoo, Finland) IN: Structures, Structural Dynamics and Materials Conference, 27th, San Antonio, TX, May 19-21, 1986, Technical Papers. Part 1 . New York, American Institute of Aeronautics and Astronautics, 1986, p. 695-699.
(AIAA PAPER 86-1019)

The design and development of a composite wing for the L-80 Turbo Trainer are described. The strength properties of the wing's graphite/epoxy materials are studied. The wing has a sandwich construction in order to provide sufficient stiffness with a minimum number of parts. Vacuum modeling techniques and low curing temperatures are utilized in the manufacturing of the upper and lower surface panels, main spar, leading edge, front and rear spars, and the wing ribs. The inspection of the reinforced plastic components is discussed. It is noted that the vacuum bag techniques are applicable for the manufacturing of all the large shallow parts of the composite wing; however, they are unsuitable for the development of complex structures such as wing ribs. I.F.

A86-38878*# Stanford Univ., Calif.

AEROELASTIC TAILORING OF COMPOSITE WINGS WITH EXTERNAL STORES

J. A. GREEN (Stanford University, CA) IN: Structures, Structural Dynamics and Materials Conference, 27th, San Antonio, TX, May 19-21, 1986, Technical Papers. Part 1 . New York, American Institute of Aeronautics and Astronautics, 1986, p. 710-719. refs
(Contract NGL-05-020-243)
(AIAA PAPER 86-1021)

The use of an integrating matrix solution procedure allows the aeroelastic stability of a large number of wing/store combinations to be studied with relative speed and accuracy. Results are presented which show the effects of tailoring the orientation of the plies of laminated composite wings when external stores are present. The stores utilized take the form of concentrated masses that are varied in terms of size and location, and combinations of stores are also studied. It is seen that there are cases for which small changes in the laminate can produce large changes in the aeroelastic stability boundary, and for such situations care should be used in tailoring a wing. For a given wing, the choice fiber angle to optimize the aeroelastic performance is quite sensitive to both the size and location of the store. Author

A86-38934#

STOCHASTIC FLUTTER OF NONLINEAR AEROELASTIC STRUCTURES WITH PARAMETER RANDOM FLUCTUATIONS

R. A. IBRAHIM (Texas Tech University, Lubbock) and H. HEO IN: Structures, Structural Dynamics and Materials Conference, 27th, San Antonio, TX, May 19-21, 1986, Technical Papers. Part 2 . New York, American Institute of Aeronautics and Astronautics, 1986, p. 533-543. refs
(Contract AF-AFOSR-85-0008)
(AIAA PAPER 86-0962)

The random response of nonlinear aeroelastic structural systems with time-dependent parameters is analyzed using recent developments in the mathematical theory of stochastic differential equations. In particular, the Ito stochastic calculus and the Fokker-Planck equation approach are used to derive a general differential equation which describes the evolution of the response moments. This equation constitutes an infinite coupled set of moment equations which are truncated by using two closure schemes. It is found that the random model interaction is governed mainly by the internal resonance ratio and the stiffness fluctuation intensity. The random variation of the system stiffness is shown to have a considerably greater effect on the system response than the random damping fluctuation. V.L.

A86-38945*# Old Dominion Univ., Norfolk, Va.

EFFECTS OF NONLINEAR DAMPING ON RANDOM RESPONSE OF BEAMS TO ACOUSTIC LOADING

C. MEI (Old Dominion University, Norfolk, VA) and C. B. PRASAD IN: Structures, Structural Dynamics and Materials Conference, 27th, San Antonio, TX, May 19-21, 1986, Technical Papers. Part 2 . New York, American Institute of Aeronautics and Astronautics, 1986, p. 644-653. refs
(Contract NAS1-17993)
(AIAA PAPER 86-1004)

Effects of both nonlinear damping and large-deflection are included in the theoretical analysis in an attempt to explain the experimental phenomena of aircraft panels excited at high sound pressure levels; that is the broadening of the strain response peak and the increase of the modal frequency. Two nonlinear damping models are considered in the analysis using a single-mode approach. Mean square maximum deflection, mean square maximum strain, and spectral density function of maximum strain for simply supported and clamped beams are obtained. It is demonstrated that nonlinear damping contributes significantly to the broadening of the response peak and to the mean square maximum deflection and strain. Author

A86-38966

DEVELOPMENTS IN BOUNDARY ELEMENT METHODS - 4

P. K. BANERJEE, ED. (New York, State University, Buffalo) and J. O. WATSON, ED. (Imperial College of Science and Technology, London, England) London and New York, Elsevier Applied Science Publishers, 1986, 356 p. For individual items see A86-38967 to A86-38971.

Recent developments in boundary element methods are discussed. New Hermitian cubic boundary elements are described which lead to better representations of boundary geometry and functions, particularly for fracture mechanics. A new advanced transient dynamic analysis for three-dimensional problems is presented, and stress analysis of axisymmetric bodies under nonaxisymmetric loading is discussed. A new plate bending formulation is presented in which a new class of fundamental solutions is developed which eliminates some of the problems related to strong singularities in a standard plate bending formulation. A novel application of the method to the nonlinear deformation analysis of sandwich plates and shallow shells is discussed. The first application of boundary element methods to problems of transient nonlinear heat transfer is described. A series of applications to some nonlinear geomechanics problems is

presented in which the linear part of the region is modelled by boundary elements and the nonlinear region by finite elements. Recent developments in modelling fluid flow problems in the aircraft industry are surveyed. C.D.

A86-39683
CHARACTERISTICS OF SYNTHETIC APERTURE RADARS [KHARAKTERISTIKI RADIOLOKATSIONNYKH STANTSII S SINTEZIROVANIEM]
N. A. SAZONOV Radiotekhnika (ISSN 0033-8486), April 1986, p. 28-31. In Russian.

Mathematical relations are derived for estimating the resolution and accuracy of azimuth determination by a synthetic aperture radar (SAR) under conditions of arbitrary motions of the flight vehicle and ground objects. The effect of motion parameters and phase fluctuations on the SAR characteristics is evaluated using the method of moments. V.L.

A86-39979
PROCESSES FOR THE MANUFACTURE OF AVIATION INSTRUMENT COMPONENTS (2ND REVISED AND ENLARGED EDITION) [TEKHNOLOGIIA IZGOTOVLENIIA DETALEI AVIATSIONNYKH PRIBOROV /2ND REVISED AND ENLARGED EDITION/]
A. N. GAVRILOV Moscow, Izdatel'stvo Mashinostroenie, 1985, 232 p. In Russian. refs

The principles governing the design of processes for the manufacture of aviation instrument components are reviewed, as are the technical and economic characteristics of specific manufacturing processes. In particular, attention is given to the characteristic features of the production of aviation instruments, methods for the design of standardized manufacturing processes, production automation, and methods for the calculation and analysis of machining errors and tolerances. Other topics discussed include ways of increasing the reliability of aviation instruments at the stage of production, selection of an optimal process for the manufacture of specific components, and characteristics of processes for the manufacture of various types of components, including bushings, threaded parts, gears, permanent magnets, gyroscope components, and printed circuits. V.L.

N86-26326# Societe Francaise d'Instruments de Mesure, Velizy-Villacoublay (France). Secteur Capteur Optronique.
USE OF A CO2 LASER LIDAR FOR FLIGHT AND PENETRATION AT VERY LOW ALTITUDES [UTILISATION D'UN LIDAR A LASER CO2 POUR LE VOL ET LA PENETRATION A TRES BASSE ALTITUDE]
B. STEPHAN *In* AGARD Guidance-Control-Navigation Automation for Night All-Weather Tactical Operations 8 p Oct. 1985
Avail: NTIS HC A07/MF A01

A CO2 laser optical sensor system which allows the acquisition of accurate land distances for a large area is described. These values are obtained in a real-time mode with the use of a UMP 7800 computer, and allow the generation of a map of the terrain to determine geographic coordinates. This map makes it possible to determine the optimal navigation trajectory at very low altitudes, with optimization based on the terrain features. This sensor was tested at Villacoublay in 1984 and is currently under testing at C.E.V. The results of the experiments and the static and dynamic analysis tests are presented. Transl. by T.R.

N86-26480# Army Engineer Waterways Experiment Station, Vicksburg, Miss. Geotechnical Lab.
COMPARATIVE STUDY OF NONDESTRUCTIVE PAVEMENT TESTING, WES (WATERWAYS EXPERIMENT STATION) NDT (NONDESTRUCTIVE TESTS) METHODOLOGIES Final Report
J. W. HALL and D. R. ALELXANDER Sep. 1985 66 p
(AD-A163379; WES-MP-GL-85-26) Avail: NTIS HC A04/MF A01 CSCL 13B

A demonstration of nondestructive airfield pavement evaluation procedures conducted by the US Army Engineer Waterways Experiment Station (WES) using both the WES 16-kip vibrator and a Dynatest falling weight deflectometer (FWD) is described. The nondestructive tests (NDT) were conducted at MacDill Air Force Base on five pavement test areas consisting of asphaltic concrete, portland cement concrete, and composite pavements. Two methods of data analysis were used. The dynamic stiffness modulus (DMS) method used dynamic deflection data from the WES 16-kip vibrator with a correlation analysis developed a number of years ago by WES. This method uses a correlation between the DSM (a load-deflection ratio) and the allowable load on a single wheel as derived from traditional test pit methods. The second analysis scheme used measured deflection basins at the pavement surface and layered elastic theory. Elastic moduli are computed by matching measured deflection basins with computed basins. Limiting stress/strain is then used to compute allowable aircraft loadings. This method was used with data from both the WES 16-kip vibrator and the FWD. Also demonstrated was a method of determining joint load transfer and of making appropriate adjustments to the allowable load to account for lack of load transfer. GRA

N86-26501# Human Engineering Labs., Aberdeen Proving Ground, Md.
A COMPARISON OF VOICE AND KEYBOARD DATA ENTRY FOR A HELICOPTER NAVIGATION TASK Final Report
F. J. MALKIN and K. A. CHRIST Dec. 1985 42 p
(AD-A163245; HEL-TM-17-85) Avail: NTIS HC A03/MF A01 CSCL 17B

The Doppler navigation set, AN/ASN 128 was used to compare manual keyboard data entry of navigation map coordinates with an isolated-word speech recognition system. Twelve male Army aviators entered data by keyboard and by voice while controlling a helicopter flight simulator. The results indicated that although the keyboard mode was faster than the voice mode of data entry, the aviators preferred using voice. Voice data entry was perceived as requiring less effort and reducing pilot workload. However, the relative slowness and low accuracy (85.5 percent) of voice data entry highlight the limitations that may exist for speech recognition systems in performing time or task critical functions. GRA

N86-26546*# Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Mechanical Engineering.
THERMODYNAMIC EVALUATION OF TRANSONIC COMPRESSOR ROTORS USING THE FINITE VOLUME APPROACH Semiannual Status Report, 20 Dec. 1985 - 31 May 1986
S. NICHOLSON and J. MOORE 1986 81 p
(Contract NAG3-593)
(NASA-CR-176840; NAS 1.26:176840; JM/86-2) Avail: NTIS HC A05/MF A01 CSCL 20D

The finite volume explicit time marching method was refined and improved. Previously, extension had been made to the finite volume method to improve the accuracy of the calculation of total pressure in inviscid flow, extend the method to allow the calculation of laminar and turbulent boundary layers in internal flows, and improve the shock capturing properties of the method by introducing a Mach number dependent interpolation scheme for the pressure used in the calculating the density. The current work extends these developments by using the new pressure interpolation scheme in two dimensional viscous calculations, including a more complete description of the viscous stresses, introducing a criteria for the transverse upwind differencing which is a function of the ratio of transverse and streamwise mass fluxes, and allowing the calculation of internal flow where boundary layers are present on both walls of the duct. The manner in which the viscous stresses are evaluated in the nonorthogonal, nonuniform grid is detailed. The convergence is investigated and results for calculations of laminar flow in a converging duct are presented. Results for calculations of transonic flow in a converging-diverging nozzle are presented and the results are compared with Sajben's measurements and calculations by others. Author

N86-26596*# Sverdrup Technology, Inc., Cleveland, Ohio.
CALIBRATION OF DROPLET SIZING AND LIQUID WATER CONTENT INSTRUMENTS: SURVEY AND ANALYSIS Interim Report
E. C. HOVENAC May 1986 30 p refs Sponsored in part by FAA, Atlantic City, N.J.
(Contract NAS3-24105)
(NASA-CR-175099; E-3025; NAS 1.26:175099; FAA-CT-86-19)
Avail: NTIS HC A03/MF A01 CSCL 14B

Results are presented for phase 1 of an effort to establish a unified calibration capability for instruments used for aircraft icing certification and aircraft icing research. Various calibration, data correction, and verification procedures are reviewed and some new techniques are developed for droplet sizing instruments and liquid water content meters. These instruments include a forward scattering spectrometer probe, an optical array probe, and hot-wire type liquid water content meters. Work planned for phase 2 of the effort is described. Author

N86-26603# Calspan Advanced Technology Center, Buffalo, N.Y.
AN EVALUATION OF THE CAPABILITY OF THE SURFACE CONDITION ANALYZER (SCAN) SENSORS TO MEASURE RUNWAY WATER DEPTH Final Report, Mar. 1981 - Jan. 1986
C. W. ROGERS, E. J. MACK, and B. J. WATTLE Jan. 1986 58 p
(Contract N00014-81-C-0443)
(AD-A164719; CALSPAN-6857-M-1) Avail: NTIS HC A04/MF A01 CSCL 14B

Field tests of Surface Systems, Inc.'s Surface Condition Analyzer's (SCAN) capability to measure runway water depth during rainfall events were performed at the Spirit of St. Louis Airfield, St. Louis, Mo., during March-May of 1985. These limited tests were scheduled to provide data in real rainfall events and to answer questions of sensor capability relative to true runway water depth and or sensor installation and siting protocol--i.e., should the sensor surface be horizontal or flush relative to a sloping runway surface. Field calibration checks showed that sensors installed in the runway surface can measure in-situ water depth in the range 0.030 to 0.40 inches (+ or = 0.01 inches). In real rainfall with rates ranging from 0.30 inches/hour (very light) to 6.0 inches/hour (heavy), it was found that the sensor-measured water depth correlated very well with an independently measured water depth over the range 0.03 to 0.10 inches (maximum observed). At the lower end of this range, both sensors measured the same water depth, while at the top end, the sloping, flush-mounted sensor indicated only about 75% of the water depth measured independently and by the horizontally mounted sensor. GRA

N86-26629*# Garrett Turbine Engine Co., Phoenix, Ariz.
PRELIMINARY EVALUATION OF A COMPOUND CYCLE ENGINE FOR SHIPBOARD GENSETS
J. G. CASTOR and W. T. WINTUCKY (National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.) Jun. 1986 29 p Sponsored by NASA. Prepared in cooperation with Naval Ship Research and Development Center, Annapolis, Md. Development Center, Annapolis, Md.
(Contract NAS3-24346)
(NASA-CR-179451; NAS 1.26:179451; DTNSRDC-PASD-CR-1886; GARRETT-21-5869; AVSCOM-TR-86-C-20) Avail: NTIS HC A03/MF A01 CSCL 13I

The results of a thermodynamic cycle (SFC) and weight analysis performed to establish engine configuration, size, weight and performance are reported. Baseline design configuration was a 2,000 hour MTBO Compound Cycle Engine (CCE) for a helicopter application. The CCE configuration was extrapolated out to a 10,000 MTBO for a shipboard genset application. The study showed that an advanced diesel engine design (CCE) could be substantially lighter and smaller (79% and 82% respectively) than todays contemporary genset diesel engine. Although the CCE was not optimized, it had about a 7% reduction in mission fuel consumption over today's genset diesels. The CCE is a turbocharged, power-compounded, high power density, low-compression ratio diesel engine. Major technology development areas are presented. Author

N86-26653*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
BUCKLING BEHAVIOR OF RENE 41 TUBULAR PANELS FOR A HYPERSONIC AIRCRAFT WING
W. L. KO, J. L. SHIDELER, and R. A. FIELDS May 1986 31 p refs Presented at the AIAA/ASME/ASCE/AHS 27th Structures, Structural Dynamics and Materials Conference, San Antonio, Texas, 19-21 May 1986
(NASA-TM-86798; H-1327; NAS 1.15:86798; AIAA-86-0978)
Avail: NTIS HC A03/MF A01 CSCL 20K

The buckling characteristics of Rene 41 tubular panels for a hypersonic aircraft wing were investigated. The panels were repeatedly tested for buckling characteristics using a hypersonic wing test structure and a universal tension/compression testing machine. The nondestructive buckling tests were carried out under different combined load conditions and in different temperature environments. The force/stiffness technique was used to determine the buckling loads of the panel. In spite of some data scattering, resulting from large extrapolations of the data fitting curve (because of the termination of applied loads at relatively low percentages of the buckling loads), the overall test data correlate fairly well with theoretically predicted buckling interaction curves. Also, the structural efficiency of the tubular panels was found to be slightly higher than that of beaded panels. Author

N86-26661# National Aerospace Lab., Amsterdam (Netherlands). Structures and Materials Div.
THE POSTBUCKLING BEHAVIOR OF BLADE-STIFFENED CARBON EPOXY PANELS LOADED IN COMPRESSION
J. F. M. WIGGENRAAD 19 Feb. 1985 20 p
(Contract NIVR-312.2-1019)
(NLR-MP-85019-U; B8577052; ESA-86-96977-L) Avail: NTIS HC A02/MF A01

The postbuckling behavior of blade-stiffened carbon epoxy panel laminates consisting of only a few layers due to the relatively low design loads was studied in compression tests. Certain coupling terms in the stiffness matrices were thought to be no longer insignificant. The full scale panels buckle in a global mode and do not show any postbuckling strength. The short columns, buckling in a local mode, support 1.8 times the initial buckling load before failure. Comparison with calculations shows that the influence of the coupling terms on the buckling behavior of the specimens is relatively small: it decreases the buckling load slightly, does not change the end shortening curves significantly and is mainly apparent in the out-of-plane deflections. ESA

N86-26662# National Aerospace Lab., Amsterdam (Netherlands). Structures and Materials Div.
SOME TESTS TO ASSESS THE EFFECT OF CRACK STOPPERS ON THE FATIGUE LIFE OF CENTER-NOTCHED SPECIMENS
J. SCHIJVE and F. A. JACOBS Feb. 1984 33 p refs
(NLR-TR-84051-U; B8576224; ESA-86-96981) Avail: NTIS HC A03/MF A01

Crack stoppers were evaluated in crack propagation tests on Alclad 2024-T3 sheet specimens (thickness 2 mm) provided with a central crack to assess the usefulness of very simple crack stopping elements which can be applied to macrocracks in sheet metal structures accessible from one side only. Results show that a stop hole at the crack tip should be filled to obtain a good propping of the hole. Self tapping screws and tapered pins give large crack growth retardation lives. Large retardations are obtained with hard driven rivets and with heavily tightened bolts in the stop holes, but they require accessibility from two sides. Flight-simulation loading on specimens with tightened bolts indicates a significant retardation, but quantitatively the effects under flight-simulation loading and under constant-amplitude loading are highly different. ESA

N86-26663# National Aerospace Lab., Amsterdam (Netherlands). Structures and Materials Div.
CONSTANT AMPLITUDE AND FLIGHT SIMULATION OF FATIGUE TESTS ON ADHESIVE BONDED LAP JOINT SPECIMENS OF 2024-T3 SHEET MATERIAL
J. SCHIJVE and F. A. JACOBS 9 Aug. 1984 47 p refs
(Contract NIVR-1725)
(NLR-TR-84090-U; B8576223; ESA-86-96982) Avail: NTIS HC A03/MF A01

Fatigue tests were carried out on Redux and FM 123/5 bonded specimens at various stress levels, temperatures (RT to 65C) and low and high test frequencies. Type of failure (bond line failure or sheet failure) and the significance of the adhesive squeeze-out for crack nucleation were examined. Results indicate that the fatigue notch effect of a thickness increase as a result of adhesive bonding of sheet material is very small; the effect of secondary bending is more significant. If the bending effect is not excessive (depending on the design) the fatigue strength of a bonded lap joint is high. In flight-simulation tests, bond line failures do not occur even under severe test conditions. The life in flight is highly superior to results for riveted lap joint and a single shear strap joint, while it is of the same order of magnitude found for riveted double-strap joints. ESA

N86-27219# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
A VORTEX POINT METHOD FOR CALCULATING INVISCID INCOMPRESSIBLE FLOWS AROUND ROTARY WINGS
B. CANATLOUBE and S. HUBERSON *In its* La Recherche Aerospatiale. Bimonthly Bulletin, no. 1984-6, November - December 1984 (ESA-TT-907) 13 p May 1985 Previously announced in IAA as A86-12021
Avail: NTIS HC A04/MF A01; HC also available in English and French from ONERA, Paris FF 70

An integral method is presented for calculating incompressible inviscid unsteady flow around thin bodies in arbitrary motion, i.e., rotor blades in motion with respect to one another. Because an integral method is used, discretization is limited to the solid boundaries and the vortices. Boundary conditions are treated in terms of equation for the slipstream on the walls, the vorticity vector, a volume integral for the vorticity and a first-order Fredholm integral. The Helmholtz equation governs the evolution of vorticity, which forms a sheet of doublets. The pressure jumps on the blades are covered by the unsteady Bernoulli equation. Applications of the method to helicopter rotors, medium- and high-aspect ratio propellers and low-aspect ratio nautical propellers are demonstrated. M.S.K. (IAA)

N86-27467*# National Aeronautics and Space Administration. Pasadena Office, Calif.
OXYGEN CHEMISORPTION CRYOGENIC REFRIGERATOR Patent Application
J. A. JONES, inventor (to NASA) (Jet Propulsion Lab., California Inst. of Tech., Pasadena) 24 Apr. 1986 15 p Sponsored by NASA
(NASA-CASE-NPO-16734-1-CU; NAS 1.71:NPO-16734-1-CU; US-PATENT-APPL-SN-855982) Avail: NTIS HC A02/MF A01 CSCL 13I

The present invention relates to a chemisorption compressor cryogenic refrigerator which employs oxygen to provide cooling at 60 K to 100 K. The invention includes dual vessels containing an oxygen absorbent material, alternately heated and cooled to provide a continuous flow of high pressure oxygen, multiple heat exchangers for precooling the oxygen, a Joule-Thomson expansion valve system for expanding the oxygen to partially liquefy it and a liquid oxygen collection vessel. The primary novelty of the present invention lies in the provision of a refrigeration system which makes use of reversible chemical reactions with oxygen to provide cooling at 60 K to 100 K. NASA

N86-27468# Shock and Vibration Information Center (Defense), Washington, D. C.
THE SHOCK AND VIBRATION DIGEST, VOLUME 18, NO. 1 Monthly Report
J. NAGLE-ESHLEMAN, ed. Jan. 1986 116 p
(AD-A165726) Avail: SVIC, Code 5804, Naval Research Lab., Washington, D.C. 20375 CSCL 20K

Topics addressed include: mechanical systems, analysis and design, structural systems, vehicle systems, biological systems, mechanical components, structural components, electric components, dynamic environment, mechanical properties, and experimentation. Literature review of the behavior of elastomeric material under dynamic loads and rotor instability in centrifugal pumps is also presented.

N86-27471# Shock and Vibration Information Center (Defense), Washington, D. C.
THE SHOCK AND VIBRATION DIGEST, VOLUME 17, NO. 8 Monthly Report
J. NAGLE-ESHLEMAN, ed. Aug. 1985 117 p
(AD-A165115) Avail: SVIC, Code 5804, Naval Research Lab., Washington, D.C. 20375 CSCL 20K

Topics adressed include mechanical systems, structural systems, vehicle systems, biological systems, mechanical components, electric components, structural components, analysis and design, dynamic environment, mechanical properties, and experimentation. Literature on noise transmission into propeller aircraft is reviewed. Computer automated failure predictions in mechanical systems are discussed.

N86-27624# Royal Netherlands Aircraft Factories Fokker, Amsterdam.
PRINCIPLES AND APPLICATIONS OF THE FOKKER BOND TESTER
J. J. C. CAARLS, R. J. QUERIDO, and A. G. JULIER 1985 21 p Presented at Air Transport Association of America Nondestructive Testing Forum, Miami, Fla., 17-20 Sep. 1985
(Contract BMFT-0101-ZA/WF/WRD-174/4)
(ESA-86-96960) Avail: NTIS HC A02/MF A01

An instrument for testing adhesive bonding of aircraft structures is described. Factors determining bond strength; principle of operation; and the use of correlation charts are discussed. Automation and improvements to the instrument since its introduction are outlined. ESA

N86-27630* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
OPTIMIZED BOLTED JOINT Patent
L. J. HART-SMITH (McDonnell-Douglas Corp., Long Beach, Calif.), B. L. BUNIN, and D. J. WATTS, inventors (to NASA) 1 Apr. 1986 9 p Filed 23 Jan. 1984 Supersedes N84-20859 (22 - 11, p 1664) Sponsored by NASA. Langley Research Center
(NASA-CASE-LAR-13250-1; US-PATENT-4,579,475; US-PATENT-APPL-SN-573162; US-PATENT-CLASS-403-312; US-PATENT-CLASS-403-388; US-PATENT-CLASS-403-408.1)
Avail: US Patent and Trademark Office CSCL 13I

A method is disclosed for joining segments of the skin of an aircraft. The ends of the skin are positioned in close proximity or abutt each other. The skin is of constant thickness throughout the joint and is sandwiched between splice plates, which taper in thickness from the last to the first bolt rows in order to reduce the stiffness of the splice plate and thereby reduce the load transfer at the location where bypass loads are the highest.
Official Gazette of the U. S. Patent and Trademark Office

N86-27632# Rolls-Royce Ltd., Derby (England).
DESIGN, DEVELOPMENT AND OPERATION OF A HIGH SIMULTANEOUS CAPACITY DIGITAL TELEMETRY SYSTEM
K. BRADLEY *In* Von Karman Inst. for Fluid Dynamics Measurements Techniques in Turbomachines, Volume 2 32 p 1985
Avail: NTIS HC A17/MF A01

A digital telemetry system for measuring pressures in interblade passages on large fan engines and model fan rigs was developed. The telemetry system replaces the slip-rings used in previous tests, and incorporates on rotor digitization and hybrid circuit techniques. Simultaneous cpacity is 48 measurements, in the dc to 3 kHz bandwidth. Measurement accuracy is + or - 0.5% fsd (dc) to 1.0% fsd (ac). Dynamic range is 60 dB. Input sensitivity is 0 to 80 mV for 0 to 25 psia. Applications are to an RB 211 development engine and a model scale fan rig. Engine shaft speed is 3900 rpm, rig speed is 10,000 to 11,000 rpm. Author (ESA)

N86-27678# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).
STATIC AEROELASTICITY IN COMBAT AIRCRAFT
Jan. 1986 42 p
(AGARD-R-725; ISBN-92-835-1516-1) Avail: NTIS HC A03/MF A01

A review of fighter aircraft development programs over the past three decades indicates a trend of increasing emphasis on the consideration of static aeroelastic effects. While early concerns addressed only the impact on air vehicle structural integrity, current design philosophy recognizes and addresses aeroelasticity as a primary design parameter affecting structural optimization, vehicle aerodynamic stability, control effectiveness, and overall performance. Examples from wind tunnel testing, analytical studies, and operational applications are presented to justify this emphasis, illustrate current methodology and analysis techniques, and make a case for an integrated approach to the consideration of static aeroelastic effects at all stages of the design process. Author

13

GEOSCIENCES

Includes geosciences (general); earth resources; energy production and conversion; environment pollution; geophysics; meteorology and climatology; and oceanography.

A86-37451
INTERNATIONAL CONFERENCE ON THE AVIATION WEATHER SYSTEM, 2ND, UNIVERSITE DU QUEBEC, MONTREAL, CANADA, JUNE 19-21, 1985, PREPRINTS
Conference sponsored by the American Meteorological Society, Canadian Meteorological and Oceanographic Society, ICAO, and WMO. Boston, MA, American Meteorological Society, 1985, 388 p. For individual items see A86-37452 to A86-37512.

The present conference considers weather forecasters' liability for inaccurate forecasts, the ICAO's World Area Forecast System, the FAA's future aviation weather system and its current Automated Weather Observing System, aircraft icing observation and analysis, the unified message switch and its application to aviation weather support, the hazards of ash clouds to civil air transport, NASA storm hazards research in lightning strikes to aircraft, and terrain-induced wind shear as the possible cause of the Jetstar N520S accident. Also discussed are the uncertainty of visibility measurements in radiation fog, challenges for clear air turbulence research, modernization of weather support for NASA's STS, the 'nowcasting' of rain, freezing rain and thunderstorms, the numerical simulation of precipitation-induced downbursts, and the role of thermodynamic effects in severe downdrafts. Attention is finally given to the USAF Automated Weather Distribution System, technological improvements to Naval Aviation weather support, a meteorological interactive data display system, and weather research and logistics at Cape Canaveral. O.C.

A86-37454
THE SAFETY AND ECONOMIC IMPACT OF IMPROVED AVIATION WEATHER SERVICES
J. W. HINKELMAN, JR. (NOAA, PROFS Program Office, Boulder, CO) IN: International Conference on the Aviation Weather System, 2nd, Montreal, Canada, June 19-21, 1985, Preprints . Boston, MA, American Meteorological Society, 1985, p. 29-40. refs

Flight safety and operational efficiency in both en route and terminal airspace are expected to be substantially enhanced by the novel Aviation Weather System. These improvements will be due to improved radar detection, identification and tracking, more automated surface observations, the automation of upper air observations by means of a national profiler system, and the automated collection/processing/distribution of pilot reports. Automation will also allow the tailoring of weather data for direct operational application, and could provide real-time hazardous weather avoidance assistance to pilots. O.C.

A86-37456
NMC PLANS FOR IMPROVED AVIATION GUIDANCE
J. A. BROWN, JR., R. D. MCPHERSON, and J. P. GERRITY, JR. (NOAA, Development Div., Washington, DC) IN: International Conference on the Aviation Weather System, 2nd, Montreal, Canada, June 19-21, 1985, Preprints . Boston, MA, American Meteorological Society, 1985, p. 44-47.

The numerical weather forecasting efforts of the U.S. National Meteorological Center are focused on the use of the Class VI CYBER 205 computer. A totally revised Regional Analysis and Forecast System was introduced into the operational production schedule in 1985; more recently, the global forecasting system was revised to separate the Medium Range Forecast guidance for 3-10 day intervals from the twice-daily global forecasts (which primarily address international aviation requirements). In both cases, significant forecast improvements have been achieved. O.C.

A86-37458
THE FEDERAL AVIATION ADMINISTRATION FUTURE AVIATION WEATHER SYSTEM
E. MANDEL (FAA, Washington, DC), M. MANN (Martin Marietta Corp., Washington, DC), and J. KEFALIOTIS (Stanford Telecommunications, Inc., Washington, DC) IN: International Conference on the Aviation Weather System, 2nd, Montreal, Canada, June 19-21, 1985, Preprints . Boston, MA, American Meteorological Society, 1985, p. 55-62.

The National Airspace System's weather system upgrading effort attempts to ensure the availability of adequate weather data to pilots, in the interest of hazard avoidance and effective traffic flow planning. Dramatic improvements have been made by this program in such areas as weather sensors, data processing, and weather display/distribution systems. Attention is given to the Next Generation Weather Radar, the Automated Weather Observing System, the Low Level Windshear Alert System, Runway Visual Range systems, and the Airport Surveillance Radar Weather channel 'ASR-9'. O.C.

A86-37459
THE FAA AUTOMATED WEATHER OBSERVING SYSTEM (AWOS)
R. H. CHRISTIANSEN and F. E. GILK (Kentron International, Inc., Arlington, VA) IN: International Conference on the Aviation Weather System, 2nd, Montreal, Canada, June 19-21, 1985, Preprints . Boston, MA, American Meteorological Society, 1985, p. 63-68.

The FAA's Automated Weather Observing System (AWOS) will furnish weather parameters to pilots, during takeoff and landing phases of flight, and ATC personnel, for the management of a given ATC zone. At a minimum, AWOS will detect and report wind speed and direction, temperature, dew point, pressure, cloud cover and height, and precipitation. Computer generated voices over telephones and ground-air radios will both be used for AWOS

data distribution, and its digitized weather observation data will be transmitted over various data links to the National Weather Network. O.C.

A86-37460
AUTOMATION OF SURFACE OBSERVATIONS PROGRAM
S. E. SHORT (NOAA, National Weather Service, Silver Spring, MD) IN: International Conference on the Aviation Weather System, 2nd, Montreal, Canada, June 19-21, 1985, Preprints . Boston, MA, American Meteorological Society, 1985, p. 69-75.

A prospective performance assessment is presented for the nationwide implementation of Automated Surface Observing Systems (ASOS). Two ASOS capability levels are planned: a basic level system for the automatic observation of aviation operations-supporting weather parameters, and a more completely automated stand-alone system for observing and reporting the full range of weather parameters. About 250 ASOS units are scheduled for operation by the end of the 1980s, at nearly all current National Weather Service primary observation sites; the majority of these will initially be basic systems, but most will ultimately be enhanced to full automation as the necessary sensors become available. O.C.

A86-37461
THE FAA/M.I.T. LINCOLN LABORATORY DOPPLER WEATHER RADAR PROGRAM
J. E. EVANS (MIT, Lexington, MA) and D. H. TURNBULL (FAA, Washington, DC) IN: International Conference on the Aviation Weather System, 2nd, Montreal, Canada, June 19-21, 1985, Preprints . Boston, MA, American Meteorological Society, 1985, p. 76-79. FAA-sponsored research.

Attention is given to the development status of a Next Generation Weather Radar-like transportable weather radar support facility which is being used to validate and refine scanning strategies, data processing methods, and weather detection algorithms applicable to the FAA's Terminal Doppler Weather Radar. Among the operational issues to be resolved by these research efforts are siting, optimum scanning strategy, optimum update rate, and interfacing with ATC facilities. Emphasis will be given to the development of a microburst-detection algorithm. O.C.

A86-37462
THE CENTER AND CENTRAL FLOW WEATHER SERVICE UNIT PROGRAM
J. UECKER and M. TOMLINSON (NOAA, National Weather Service, Silver Spring, MD) IN: International Conference on the Aviation Weather System, 2nd, Montreal, Canada, June 19-21, 1985, Preprints . Boston, MA, American Meteorological Society, 1985, p. 80-83.

Begun at 13 Air Route Traffic Control Centers in April, 1978, the Center and Central Flow Weather Service Unit programs have expanded to 21 sites in the coterminous US and in Alaska. Attention is given to the current status of these FAA-National Weather Service collaborative programs, with a view to the efficiency with which observations, forecasts and warnings of potentially hazardous weather conditions can be delivered to pilots. Briefing, meteorological impact statement, and Center Weather Advisory products are illustrated. O.C.

A86-37466
A COLD-SEASON NORTH AMERICAN CLIMATOLOGY OF STRONG VERTICAL WIND SHEAR
M. CAI and J. R. GYAKUM (Illinois, University, Urbana) IN: International Conference on the Aviation Weather System, 2nd, Montreal, Canada, June 19-21, 1985, Preprints . Boston, MA, American Meteorological Society, 1985, p. 98, 99.
(Contract NSF ATM-83-05096; NSF ATM-83-11175)

The strong vertical wind shear (SWS) zones above the surface boundary layer were investigated during the North American cold season by utilizing the excellent vertical resolution of the significant level wind data of a rawinsonde. Six-month twice-daily mandatory-level sounding data, including geopotential height, temperature and wind information, and significant wind and temperature data, of October 1, 1983 to March 31, 1984 were examined from latitude 25-70 N and longitude 50-130 W. SWS is defined as being geostrophically equivalent to a horizontal temperature contrast of 15.5 C/500 km (Sanders, 1967). It is found that during the cold season the tropospheric SWS zones occur preferentially in middle latitudes and in the western and eastern coastal North American regions, and a distinct minimum of events is observed in the central section of the continent at all levels. R.R.

A86-37484
WINDSHEAR DETECTION USING A DOPPLER ACOUSTIC SOUNDER (SODAR)
J. M. FAGE and P. HUGUET (Remtech, S. A., Velizy-Villacoublay, France) IN: International Conference on the Aviation Weather System, 2nd, Montreal, Canada, June 19-21, 1985, Preprints . Boston, MA, American Meteorological Society, 1985, p. 192-195. refs

Use of Doppler sodar for obtaining windshear and meteorological data is discussed. The sodar mesaures wind speed and wind direction, vertical wind speed, turbulence, and thermal stratification at altitudes up to 2000 ft, with about 100 ft resolution and 1-min time step. The sodar was shown to operate efficiently at adverse conditions of heavy rain, strong wind, or high background noise, and for all meteorological situations a high degree of correlation was obtained between the sodar and the airborne wind data. By combining a vertically pointed sodar with a network of anemometers of the Low Level Windshear Alarm System (LLWAS), a three-dimensional description of the windflow around airports is achieved, detecting the windshear associated with low level jets or with temperature inversion layers. The sodar is also successfully applied in the field of air pollution control. I.S.

A86-37485
EVALUATION OF THE ASR-9 WEATHER REFLECTIVITY PRODUCT
M. E. WEBER (MIT, Lexington, MA) and J. R. ANDERSON (Illinois, University, Urbana) IN: International Conference on the Aviation Weather System, 2nd, Montreal, Canada, June 19-21, 1985, Preprints . Boston, MA, American Meteorological Society, 1985, p. 196-202. FAA-sponsored research.

The airport surveillance radar (ASR)-9 and its weather processor are described, and the utility of its weather reflectivity product in an air traffic control environment is evaluated. The radar transmits either linearly or circularly polarized signals, selected on the basis of air traffic control requirements. A simulation procedure that utilizes a pencil-beam Doppler weather radar data and ground clutter measurements is described. Examples of the simulated weather reports are presented to illustrate: (1) partial beamfilling due to the fan-shaped surveillance antenna pattern; (2) attenuation of low velocity weather by the clutter filters; and (3) the effects of the spatial filters used in weather processing. I.S.

A86-37487
WIDE AREA REAL-TIME THUNDERSTORM MAPPING USING LPATS - THE LIGHTNING POSITION AND TRACKING SYSTEM
W. A. LYONS, K. G. BAUER (R Scan Corp., Minneapolis, MN), R. B. BENT, and W. H. HIGHLANDS (Atlantic Scientific Corp., Melbourne, FL) IN: International Conference on the Aviation Weather System, 2nd, Montreal, Canada, June 19-21, 1985, Preprints . Boston, MA, American Meteorological Society, 1985, p. 207-214.

The principles of operation of a time-of-arrival Lightning Position and Tracking System (LPATS) network are described, together with the techniques employed to display and interact with the data base of LPATS networks currently in operation. LPATS provides an instantaneous, sub-synoptic view of thunderstorms on a single display, whereas some ten radars would be needed to be composited to provide the same thunderstorm tracking capability. Aside from providing nowcasting support to aviation forecasters, pilot briefers, and controllers, the use of the LPATS data has greatly reduced the number of false alarms associated

with other means of thunderstorms detection. Representative case studies are presented. I.S.

A86-37491

EVALUATING THE NEW AUTOMATED WEATHER OBSERVING SYSTEM

V. L. NADOLSKI and J. T. BRADLEY (NOAA, Test and Evaluation Div., Sterling, VA) IN: International Conference on the Aviation Weather System, 2nd, Montreal, Canada, June 19-21, 1985, Preprints . Boston, MA, American Meteorological Society, 1985, p. 226-232. refs

A testing method for evaluating automated weather observing systems (AWOSs) is described and applied to the Lynchburg AWOS-3 evaluation. The evaluation scheme consists of: (1) an extensive software testing to ensure the correct programming of the AWOS-3 algorithms, (2) the engineering and environmental chamber testing of the total system, and (3) field tests conducted to determine responsiveness of the system and its limitations (particularly of the sensors), and adequacy of the algorithms. The test method is applicable to other types of AWOS and will be shortly used to evaluate a sophisticated NWS Automated Surface Observing System (ASOS). I.S.

A86-37495

THE CLASSIFY, LOCATE, AND AVOID WIND SHEAR (CLAWS) PROJECT AT DENVER'S STAPLETON INTERNATIONAL AIRPORT - OPERATIONAL TESTING OF TERMINAL WEATHER HAZARD WARNINGS WITH AN EMPHASIS ON MICROBURST WIND SHEAR

J. MCCARTHY and J. WILSON (National Center for Atmospheric Research, Boulder, CO) IN: International Conference on the Aviation Weather System, 2nd, Montreal, Canada, June 19-21, 1985, Preprints . Boston, MA, American Meteorological Society, 1985, p. 247-256. NSF-supported research. refs
(Contract DOT-FA01-82-Y-10513)

A86-37496* SASC Technologies, Inc., Hampton, Va.

NUMERICAL SIMULATION OF PRECIPITATION INDUCED DOWNBURSTS

F. H. PROCTOR (SASC Technologies, Inc., Hampton, VA) IN: International Conference on the Aviation Weather System, 2nd, Montreal, Canada, June 19-21, 1985, Preprints . Boston, MA, American Meteorological Society, 1985, p. 257-264. refs
(Contract NAS1-17409)

Using the Terminal Area Simulation System (TASS), numerical simulations of downburst structure and sensitivity, based on vertical profiles of environmental temperature, humidity and wind velocity observed during the June and August 1982 JAWS project, are presented. Two-dimensional axisymmetric simulations examining downburst evolution, structure and sensitivity, assume a 40-m constant grid size on a 10-km diameter 5-km deep cylindrical domain. The three-dimensional experiment, examining the effects of vertical wind shear and other asymmetrical aspects of the downpour, assumed a 500-m constant horizontal grid size and a 35 x 35 x 18.5-km area. In the downburst primary structure depicted, outflow speeds were found to be sensitive to environmental temperature and humidity, as well as to precipitation radius and intensity. A vortex ring was found to propagate downwards, and maximum outflow winds occur when the vortex ring first reaches the surface. R.R.

A86-37497

CATEGORIZATION OF ATMOSPHERIC TURBULENCE IN TERMS OF AIRCRAFT RESPONSE FOR USE IN TURBULENCE REPORTS AND FORECASTS

E. W. TURNER (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH) IN: International Conference on the Aviation Weather System, 2nd, Montreal, Canada, June 19-21, 1985, Preprints . Boston, MA, American Meteorological Society, 1985, p. 265-268.

The USAF, in an attempt to further categorize atmospheric turbulence, has proposed a method whereby individual aircraft gust sensitivity would be taken into account. The selected approach is to utilize the gust loads formula which relates the peak accelerations to be expected on one airplane to the peak accelerations measured on another airplane for flight through the same rough air. Topics discussed in detail include: (1) the relationship between gust amplitude and aircraft size, (2) the lift curve slope, and (3) the gust alleviation factor. It is concluded that the proposed method for calculating gust sensitivity should provide sufficient accuracy for turbulence forecasting. However, the amount of time spent in turbulence and its effect on pilot fatigue must also be taken into account. K.K.

A86-37498

DEVELOPMENT OF CAT DETECTION AND FORECASTING TECHNIQUES FOR THE PROFS CENTRAL WEATHER PROCESSOR

J. L. KELLER (Dayton, University, OH) IN: International Conference on the Aviation Weather System, 2nd, Montreal, Canada, June 19-21, 1985, Preprints . Boston, MA, American Meteorological Society, 1985, p. 269-276. refs

A computer-generated Specific Clear-air Turbulence Risk (SCATR) index which may be instrumental in clear-air turbulence (CAT) detection is presented. The CAT phenomenon is most frequently found near the tropopause within jet stream/internal fronts associated with active extratropical cyclones. The SCATR index is formulated on the notion that while CAT is a subgrid-scale phenomenon in terms of what an aircraft experiences during an encounter, outbreaks of CAT are attributed to larger, grid-scale dynamical processes. The results of case studies suggest that this index provides a CAT forecast that is significantly better than those provided by traditional, subjective indices. Practical SCATR index applications include both short- and medium-range forecasts of CAT; numerical values may be used in flight-path optimization programs and flight-simulation software. In addition, this index may eventually incorporate other effects, such as terrain, which are important in determining the formation and potential intensity of CAT regions more accurately. K.K.

A86-37500

USE OF COMPUTER TECHNOLOGY IN THE OPERATIONS OF THE NATIONAL AVIATION WEATHER ADVISORY UNIT

M. D. MATHEWS (NOAA, National Severe Storms Forecast Center, Kansas City, MO) IN: International Conference on the Aviation Weather System, 2nd, Montreal, Canada, June 19-21, 1985, Preprints . Boston, MA, American Meteorological Society, 1985, p. 285-288. refs

The application of computer technology to aviation forecasting is discussed. The area forecasts contain information on hazards, the position and movement of synoptic features, icing, turbulence, and the clouds and weather. The four computer systems utilized by the in-flight meteorologists are (1) the Advanced Operating System, (2) the Automation of Field Operations and Services, (3) the Weather Message Switching Center, and (4) the Centralized Storms Information Systems. The development of pilot weather reports on icing, turbulence, and clouds and weather from the computer data is described. I.F.

A86-37501* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

UPPER AIR FORECASTING FOR AVIATION IN THE UNITED STATES

R. STEINBERG (NASA, Lewis Research Center, Cleveland, OH) IN: International Conference on the Aviation Weather System, 2nd, Montreal, Canada, June 19-21, 1985, Preprints . Boston, MA, American Meteorological Society, 1985, p. 289-294. refs

It is shown that the present forecast models used in the aviation digital forecast (ADF) product for automated flight planning in the U.S. did not improve in accuracy and precision over the past two decades. A new approach to the upper air forecasting is presented in the NASA/NOAA MERIT project. In MERIT, a concept of a tailored analysis is used, based on a high density automated aircraft report database (including radiosonde and satellite data), producing an accurate and precise description of the initial state of the atmosphere, and a relatively simple forecast model to move the

forecast forward in time. The steadily updated 2-12 h forecasts provided every 3 h will be more efficient and accurate than the present 18 and 24 h forecasts provided every 12 hours. I.S.

A86-37504
THE AVIATION WEATHER FORECASTING TASK FORCE - ASSESSING THE CURRENT SYSTEM
J. MCCARTHY and P. J. OROURKE (National Center for Atmospheric Research, Boulder, CO) IN: International Conference on the Aviation Weather System, 2nd, Montreal, Canada, June 19-21, 1985, Preprints . Boston, MA, American Meteorological Society, 1985, p. 310-315. NSF-sponsored research.
(Contract DOT-FA01-84-Z-02051)

The objectives of the Aviation Weather Forecasting Task Force that was developed to identify weather problems in the aviation industry are discussed. The need for the formation of automatic aircraft report data bases to include wind, temperature, and turbulence observations, and for more accurate numerical forecast and warning products is examined. Methods of improving aviation meteorological training, pilot weather reports, and private weather services are studied. I.F.

A86-37511
THE IMPACT OF PRIVATE METEOROLOGY ON PRIVATE AVIATION
J. BLOCK (Kavouras, Inc., Minneapolis, MN) IN: International Conference on the Aviation Weather System, 2nd, Montreal, Canada, June 19-21, 1985, Preprints . Boston, MA, American Meteorological Society, 1985, p. 344-346.

A86-39566#
AERODYNAMIC CHARACTERISTICS OF AN OSCILLATING AIRFOIL
R. H. WICKENS (National Aeronautical Establishment, Low Speed Aerodynamics Laboratory, Ottawa, Canada) Canadian Aeronautics and Space Journal (ISSN 0008-2821), vol. 32, March 1986, p. 34-49. refs

Results are reported from wind tunnel tests to study the effects of dynamic aerodynamics on the efficiency of a NACA 0018 airfoil used on a Darreius vertical axis wind turbine (VAWT). The topic is of interest because of uncontrolled pitching which occurs during operation and which produces stall, turbulence and separation effects that reduce efficiency. Present stream-tube theory and axial momentum models are not applicable in the unstable regimes. The wind tunnel tests were conducted with a 45 m/sec flow with an Re of 1.5 million. The situation mimicked typical wind turbine operational conditions. The airfoil was mounted on a hydraulic actuator to allow it to rotate about its quarter-chord location and to control the extent and frequency of oscillations. Data were also gathered on the performance in a steady flow for comparative purposes. Summary data are provided on the static and total pressures over a complete cycle of oscillation, and related to the angles of attack, time of onset of stall, and the lift and drag coefficients. The limitations of the study with regard to the absence of consideration of the flow acceleration experienced by an advancing blade are noted. M.S.K.

N86-26714# Federal Aviation Administration, Washington, D.C. Office of Environment and Energy.
A MICROCOMPUTER POLLUTION MODEL FOR CIVILIAN AIRPORTS AND AIR FORCE BASES
H. M. SEGAL, J. K. KEMP, and P. L. HAMILTON Dec. 1985 55 p
(AD-A163232; FAA-EE-85-4; AFESC/ESL-TR-85-41) Avail: NTIS HC A04/MF A01 CSCL 09B

Over the past five years, the Federal Aviation Administration and the United States Air Force have developed a number of user-friendly emissions and dispersion models for air quality assessment purposes. The first, Simplex A was completed in July 1981. The second, called Emissions and Dispersion Modeling System (EDMS), has just been completed and this report constitutes its User's Guide. First, this User's Guide shows how the EDMS system evolved from the earlier, more complex AVAP and AQAM systems. Then, it identifies the hardware and software required to run the system and provides instructions on how to add, delete or change standard information. Finally, through a 125-step example problem, it instructs the user on how to input and process data to produce: (1) an emissions inventory of all sources at an airport/airbase, and (2) an estimate of the concentrations of these sources at specified locations. An inexperienced user should be able to process the example problem in less than three hours. Author (GRA)

N86-26715# Air Force Engineering and Services Center, Tyndall AFB, Fla. Engineering and Services Lab.
AIRCRAFT ENGINE EMISSIONS ESTIMATOR Final Report, Jan. 1983 - Sep. 1985
G. D. SEITCHEK Nov. 1985 101 p refs
(AD-A164552; AFESC/ESL-TR-85-14) Avail: NTIS HC A06/MF A01 CSCL 21E

The objective of this effort is to revise the Aircraft Emission Estimation Techniques (ACEE) Handbook to reflect changes in the Air Force aircraft inventory that have occurred since 1975. A complete listing of current Air Force aircraft and their associated engines is included. Emission factors for most of these engines are provided, along with examples for calculating emissions from aircraft operations, and analyzing their impact. This report supersedes CEEDO-TR-78-33, Aircraft Emission Estimation Techniques (ACEE). Author (GRA)

N86-27727*# Air Force Geophysics Lab., Hanscom AFB, Mass.
PROFILES OF TEMPERATURE AND DENSITY BASED ON EXTREMES AT 5, 10, 20, 30 AND 40 KM
A. J. KANTOR, P. TATTELMANN, and F. A. MARCOS *In* International Council of Scientific Unions Handbook for MAP, Vol. 18 4 p Dec. 1985
Avail: NTIS HC A23/MF A01; also available from SCOSTEP Secretariat, Illinois Univ., 1406 West Green Street, Urbana, Ill. 61801 CSCL 04A

Information on the vertical distribution of expected extremes of temperature and density are required for the design and operation of systems traversing the atmosphere. Such data are particularly important at altitudes from the surface to approximately 80 km for developing all types of airborne vehicles ranging from helicopters and airplanes to sophisticated aerospace systems. Vertical profiles of temperature and density have been developed based on 1- and 10-percent hot and cold temperatures and 1- and 10- percent high and low densities occurring during the most severe month at the worst locations for which reliable upper-air data are available. The model profiles, from the surface to 80 km, are based on extremes that occur at 5, 10, 20, 30, and 40 km. There are 20 profiles for extreme temperatures (5 levels by 4 percentiles) that include associated densities, and 20 analogous profiles for extreme densities including associated temperatures. Consequently, a set of realistic profiles (rather than envelopes) of temperature and density, associated with extremes at each of 5 specified levels in the troposphere and stratosphere, are now available for altitudes up to 80 km. Author

N86-27835*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
AIRBORNE LIDAR MEASUREMENTS OF EL CHICHON STRATOSHPERIC AEROSOLS
M. P. MCCORMICK and M. T. OSBORN (SASC Technologies, Inc., Hampton, Va.) Jul. 1982 49 p Supersedes NASA-RP-1136 NASA-RP-1148
(NASA-RP-1166; L-16107; NAS 1.61:1166) Avail: NTIS HC A03/MF A01 CSCL 04A

A NASA Electra airplane outfitted with a lidar system was flown in July 1982 between the latitudes of 42 deg. N and 12 deg. N. The primary purpose of this mission was to determine the spatial distribution and aerosol characteristics of the El Chichon-produced stratospheric material. This report presents the lidar data from that flight mission. Representative profiles of lidar backscatter ratio, plots of the integrated backscattering function versus latitude, and contours of backscatter mixing ratio versus altitude and latitude

are given. In addition, tables containing numerical values of the backscatter ratio and backscattering functions versus altitude are supplied for each profile. The largest amount of material produced by the El Chichon eruptions of late March-early April 1982 which was measured by this flight resided south of 30 deg. N and was concentrated above 21 km in a layer that peaked at 24 to 27 km. In this latitude region, peak backscatter ratios at a wavelength of 0.6943 microns were approximately 50, and peak optical depths were calculated to be 0.2. This report presents the results of this mission in a ready-to-use format for atmospheric and climatic studies. Author

N86-27851# Radio Technical Commission for Aeronautics, Washington, D. C.
MINIMUM OPERATIONAL PERFORMANCE STANDARDS FOR AIRBORNE THUNDERSTORM DETECTION EQUIPMENT
May 1986 75 p
(RTCA/DO-191) Avail: NTIS HC A04/MF A01

Minimum operational performance standards for non-radar airborne thunderstorm detection equipment are explained in this document. These standards specify system characteristics that should be useful to designers, manufacturers, installers and users of the equipment. Information needed to understand the rationale for equipment characteristics and requirements is given. Typical equipment applications and operational goals as envisioned by Special Committee 154 are discussed. The minimum performance standards for the equipment are given. These standards specify the required performance under standard and environmental conditions. Also included are recommended bench test procedures necessary to demonstrate equipment compliance with the stated minimum requirements. Tests for the installed equipment are included when performance cannot be adequately determined through bench testing. The operational performance characteristics for equipment installations are described and conditions that will assure the equipment is used properly in the expected operational environment are defined. B.W.

N86-27855*# LuTech, Inc., Hayward, Calif.
ANALYSIS OF DIRECT AND NEARBY LIGHTNING STRIKE DATA FOR AIRCRAFT Final Report
D. V. GIRI, R. S. NOSS, D. B. PHUOC, and F. M. TESCHE Jun. 1983 205 p
(Contract NAS1-16893)
(NASA-CR-172127; NAS 1.26:172127) Avail: NTIS HC A10/MF A01 CSCL 04B

A method for interpreting direct strike and nearby strike lightning data on aircraft is discussed. The theoretical basis for the interpretation involves a transmission line model for the aircraft, and is discussed. Results of applying this model to the F-106 aircraft are presented and in the natural resonances are computed for several different electrical representations of the aircraft. The signal processing techniques useful for extracting pole (resonance) information from experimental data are discussed, and the use of these techniques on the measured lightning data is illustrated. Finally, the results of a related ground-based lightning experiment are discussed and data are presented. The purpose of this test was to gain additional understanding of the resonance properties of the F-106 aircraft. Author

15

MATHEMATICAL AND COMPUTER SCIENCES

Includes mathematical and computer sciences (general); computer operations and hardware; computer programming and software; computer systems; cybernetics; numerical analysis; statistics and probability; systems analysis; and theoretical mathematics.

A86-37177
TECHNIQUES FOR OPTIMIZING COMPUTER PERFORMANCE IN REAL-TIME FLIGHT SIMULATION
R. M. HOWE (Michigan, University, Ann Arbor) IN: Aerospace simulation II; Proceedings of the Second Conference, San Diego, CA, January 23-25, 1986 . San Diego, CA, Society for Computer Simulation, 1986, p. 1-12.

The dynamic performance of real-time flight simulators is often limited by inherent delays in both input and output interfaces with the computer. For example, an output interface consisting of D to A converters using zero-order extrapolation introduces the equivalent of a half-frame delay. In this paper it is shown how, by operating the simulation at a computer frame rate that is less than the maximum possible frame rate, the effect of the D to A lag and other interface delays can be completely eliminated. Additional improvements in performance can be realized by A to D sampling of continuous inputs to the simulation at a frame rate which is a multiple of the overall integration frame rate used in the digital simulation. Frequency-domain techniques are used for quantitative analysis of the dynamic accuracy of each of these interface-compensation methods. The results are compared with the dynamic performance when no compensation is used, or when more traditional compensation methods are employed. Author

A86-37180
SIMULATION SUPPORT SOFTWARE IN A REAL-TIME ENVIRONMENT AT THE U.S. AIR FORCE FLIGHT TEST CENTER
R. A. WOOD (USAF, Flight Test Center, Edwards AFB, CA) and S. E. LOUTON (Singer Co., Link Flight Simulation Div., Edwards AFB, CA) IN: Aerospace simulation II; Proceedings of the Second Conference, San Diego, CA, January 23-25, 1986 . San Diego, CA, Society for Computer Simulation, 1986, p. 41-52.

Attention is given to the character and performance of the extensive support software used by the U.S. Air Force's Flight Test Center, which has been used to educate test personnel, determine flight test envelopes, develop modifications to flight control systems, and investigate accidents. The software employed eases and systematizes both the development and operation of aircraft flight simulations. The aircraft models run under the control of the support software, which provides the interface to the user, cockpit, and remaining computer hardware. O.C.

A86-37194* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
CGI DELAY COMPENSATION
R. E. MCFARLAND (NASA, Ames Research Center, Moffett Field, CA) IN: Aerospace simulation II; Proceedings of the Second Conference, San Diego, CA, January 23-25, 1986 . San Diego, CA, Society for Computer Simulation, 1986, p. 231-262. refs

Computer-generated graphics in real-time helicopter simulation produces objectionable scene-presentation time delays. In the flight simulation laboratory at Ames Research Center, it has been determined that these delays have an adverse influence on pilot performance during agressive tasks such as nap of the earth (NOE) maneuvers. Using contemporary equipment, computer generated image (CGI) time delays are an unavoidable consequence of the operations required for scene generation. However, providing that magnitude distortions at higher frequencies are tolerable, delay compensation is possible over a restricted frequency range. This range, assumed to have an upper limit of perhaps 10 or 15 rad/sec, conforms approximately to the bandwidth associated with helicopter

handling qualities research. A compensation algorithm is introduced here and evaluated in terms of tradeoffs in frequency responses. The algorithm has a discrete basis and accommodates both a large, constant transport delay interval and a periodic delay interval, as associated with asynchronous operations. Author

A86-37395
DECOUPLING OF NONLINEAR SYSTEMS, NONCOMMUTATIVE GENERATRIX SERIES, AND LIE ALGEBRAS [DECOUPLAGE DES SYSTEMES NON LINEAIRES, SERIES GENERATRICES NON COMMUTATIVES ET ALGEBRES DE LIE]
D. CLAUDE (CNRS, Laboratoire des Signaux et Systemes, Gif-sur-Yvette, France) SIAM Journal on Control and Optimization (ISSN 0363-0129), vol. 24, May 1986, p. 562-578. In French. refs
The joint use of noncommutative generating power series and Lie algebras gives an algebraic approach for decoupling problem of nonlinear systems. A coherent decoupling method is produced using the additional notion of the immersion of a system into another, a concept which makes clear the fact that two systems have the same input-output behavior. Thus, a judicious choice of feedback which gives decoupling is able to immerse a system into a system defined on R super eta, with eta depending on the characteristic numbers of the system. Author

A86-38376
TECHNIQUES FOR SORTIE GENERATION ANALYSIS
J. A. SHIMIZU, N. CHANG, and R. S. MORRIS (Northrop Corp., Aircraft Div., Hawthorne, CA) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 18 p.
(SAE PAPER 851950)
The force effectiveness of tactical fighter units in meeting enemy threats is largely dependent on the aircraft capability to generate sorties. Sortie generation is a function of aircraft inherent design characteristics, operating conditions, and the quantity and availability of support resources. This paper examines a technique for analyzing the impact of these constraints and their interrelationships. The technique presented offers a practical approach for evaluating various operational and support policies by measuring their effect on the system's sortie generation capability. More importantly, the technique provides an important tool for evaluating the impact of design characteristics (particularly reliability and maintainability) on combat capability where the performance measure is, again, sortie generation capability. Author

A86-38807#
ASTROS - AN ADVANCED SOFTWARE ENVIRONMENT FOR AUTOMATED DESIGN
D. L. HERENDEEN, R. L. HOESLY (Universal Analytics, Inc., Playa del Rey, CA), E. H. JOHNSON (Northrop Corp., Hawthorne, CA), and V. B. VENKAYYA (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) IN: Structures, Structural Dynamics and Materials Conference, 27th, San Antonio, TX, May 19-21, 1986, Technical Papers. Part 1 . New York, American Institute of Aeronautics and Astronautics, 1986, p. 59-66. refs
(Contract F33615-83-C-3232)
(AIAA PAPER 86-0856)
The 'ASTROS' Automated Structural Optimization System combines a general purpose executive, a scientific data base management system, and a problem-oriented control language into a powerful and flexible tool for the design of engineering application software. The primary function of such software is the integration of specific functional modules from existing sources into a cohesive system for automated aerospace structure design; this encompasses, in addition to finite element methods, static and dynamic structural characteristics, aerodynamics, sensitivity analysis, optimization, and control systems. O.C.

A86-39034#
MULTI-INPUT MULTI-OUTPUT AUTOMATIC DESIGN SYNTHESIS FOR PERFORMANCE AND ROBUSTNESS
V. C. GORDON and D. J. COLLINS (U.S. Naval Postgraduate School, Monterey, CA) (Guidance, Navigation and Control Conference, Snowmass, CO, August 19-21, 1985, Technical Papers, p. 482-489) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 9, May-June 1986, p. 281-287. Previously cited in issue 22, p. 3319, Accession no. A85-45929. refs

N86-27018# National Aerospace Lab., Amsterdam (Netherlands). Flight Div.
AN EFFICIENT DECISION-MAKING-FREE FILTER FOR PROCESSES WITH ABRUPT CHANGES
H. A. P. BLOM 10 Sep. 1984 10 p Presented at 7th IFAC Symposium on Identification and System Parameter Estimation, York, England, 3-7 Jul. 1985
(NLR-MP-84080-U; B8578435; ESA-86-96970) Avail: NTIS HC A02/MF A01
The system of linear stochastic difference equations with Markovian coefficients was generalized to cover processes in R sup n which jump simultaneously with the coefficients. The additional modeling potential of this generalized system is illustrated. For filtering partial observations of the generalized system, the Interacting Multiple Model (IMM) algorithm is given. It consists of a bank of N interacting Kalman-like filters which cooperate with a filter for the N state Markov process and is free of any decision making mechanism. Comparisons with other algorithms for processes with abrupt changes show that the IMM algorithm performs very well at the cost of a relatively low computational load. Due to the generalization, the IMM algorithm is a serious competitor of decision directed filters for processes in R sup n with additive jumps. ESA

N86-27926# Lockheed-California Co., Burbank.
KRASH85 USER'S GUIDE: INPUT/OUTPUT FORMAT Final Report, Jan. 1984 - Sep. 1984
M. A. GAMON, G. WITTLIN, and W. L. LABARGE Jul. 1985 235 p
(DOT/FAA/CT-85/10-REV; LR-30777-REV) Avail: NTIS HC A11/MF A01 CSCL 09B
Program KRASH as modified under Contract DTFA03-84-C-00004 is described. The updated version is denoted KRASH85. This document is a User's Guide and defines the input and output formats appropriate for KRASH85. Features that are incorporated into KRASH85 include: an improved plastic hinge moment algorithm; gear-oleo metering pin coding; load-interaction curves; an expanded initial conditions subroutine (combined with NASTRAN); a comprehensive energy balance; center of gravity (c.g.) displacement, velocity, acceleration and force time histories; revised vertical beam orientation coding; provision to save data for post-processing i.e., acceleration, mass location and forces; provisions to input preprocessed data; a corrected uncoupled KR curve unloading/reloading algorithm; provisions to define a tire spring (remains normal to ground plane); provisions to number the masses to an arbitrary sequence; and an option to compute section shear and moment distributions. Author

N86-27929# Toronto Univ. (Ontario). Inst. for Aerospace Studies.
FLIGHT SIMULATION MOTION-BASE DRIVE ALGORITHMS. PART 2: SELECTING THE SYSTEM PARAMETERS
L. D. REID and M. A. NAHON May 1986 231 p Sponsored by tyhe Canadian Transportation Development Centre
(UTIAS-307; ISSN-0082-5255) Avail: NTIS HC A11/MF A01
A project aimed at developing and testing flight simulator motion-base drive algorithms suited for commercial jet transports is discussed. Full six degrees-of-freedom motion of a synergistic motion-base is being studied. Three forms for these algorithms are being considered: (1) classical linear washout, (2) optimal control, and (3) coordinated adaptive washout. It is felt that the latter two techniques may provide some advantages over the classical, which is currently employed in most commercial flight

simulators. A filter parameter selection process using typical jet transport maneuvers as input signals is discussed. The filter parameters were adjusted to produce a range of washout characteristics. The pilot's motion sensations produced by these tests were estimated through the use of linear models of the human vestibular system. Nine sets of washout filters were generated for future evaluation by a group of pilots. Computer listings of the real-time software are presented along with numerous test results. Author

N86-27930*# College of William and Mary, Williamsburg, Va. Dept. of Computer Science.
A HIGH-ORDER LANGUAGE DOR A SYSTEM OF CLOSELY COUPLED PROCESSING ELEMENTS Final Report
S. FEYOCK and W. R. COLLINS Jul. 1986 67 p
(Contract NAG3-232)
(NASA-CR-177280; NAS 1.26:177280) Avail: NTIS HC A04/MF A01 CSCL 09B

The research reported in this paper was occasioned by the requirements on part of the Real-Time Digital Simulator (RTDS) project under way at NASA Lewis Research Center. The RTDS simulation scheme employs a network of CPUs running lock-step cycles in the parallel computations of jet airplane simulations. Their need for a high order language (HOL) that would allow non-experts to write simulation applications and that could be implemented on a possibly varying network can best be fulfilled by using the programming language Ada. We describe how the simulation problems can be modeled in Ada, how to map a single, multi-processing Ada program into code for individual processors, regardless of network reconfiguration, and why some Ada language features are particulary well-suited to network simulations. Author

16

PHYSICS

Includes physics (general); acoustics; atomic and molecular physics; nuclear and high-energy physics; optics; plasma physics; solid-state physics; and thermodynamics and statistical physics.

A86-39057*# Missouri Univ., Rolla.
WAVE ENVELOPE AND FINITE ELEMENT APPROXIMATIONS FOR TURBOFAN NOISE RADIATION IN FLIGHT
A. V. PARRETT (GM Noise and Vibration Laboratory, Milford, MI) and W. EVERSMAN (Missouri-Rolla, University, Rolla) AIAA Journal (ISSN 0001-1452), vol. 24, May 1986, p. 753-760. Previously cited in issue 01, p. 75, Accession no. A85-10877. refs
(Contract NAG1-198)

A86-39058*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
FLIGHT EFFECTS ON NOISE FROM COAXIAL DUAL FLOW. I - UNHEATED JETS
R. DASH (NASA, Ames Research Center, Moffett Field, CA) AIAA Journal (ISSN 0001-1452), vol. 24, May 1986, p. 761-769. Previously announced in STAR as N83-17238. refs
(Contract NCC2-75)

The effects of flight on sound radiated from embedded, uncorrelated ring sources convecting along the midst of the primary and the secondary streams of a coaxial dual flow which emerges from a moving nozzle into the ambience are studied. Cold jets are examined. The problem is posed as a double vortex-sheet flow model which involves deliberate suppression of inherent instabilities of the flow and is formulated, as a linear problem, in terms of the combined contributions of two independent uncorrelated quadrupole-type ring sources, the one convecting in the primary flow representing the sources generated due to the interaction at the primary/secondary interface and the other convecting in the secondary flow representing the sources generated due to the interaction at the secondary/ambient interface. The analysis shows that the effects of flight induce: (1) amplication of noise in the forward quadrant, (2) reduction of noise in the aft quadrant and (3) absolutely no impact on radiation of noise at Theta = 90 deg to the jet axis. Author

A86-39069#
FINE STRUCTURE OF SUBSONIC JET NOISE
W. G. RICHARZ (Carleton University, Ottawa, Canada) AIAA Journal (ISSN 0001-1452), vol. 24, May 1986, p. 849, 850. NSERC-supported research.

An examination is conducted of the fine structure of the sound pressure spectrum of a subsonic jet, in order to correlate the fine structure with the sound from large scale structures in the jet flow. It is noted that the phenomenon of diffraction appears to be responsible for the observed fine structure. Attention is given to the influence of the analysis technique on the appearance of far field pressure spectra. O.C.

N86-26804# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (West Germany).
FLIR, NVG AND HMS/D SYSTEMS FOR HELICOPTER OPERATION: REVIEW
H. D. V. BOEHM *In* AGARD Visual Protection and Enhancement 27 p Dec. 1985 refs
Avail: NTIS HC A11/MF A01

In the last decade, electro-optical systems have been used successfully in military and civil applications. They extend the scope of operation of ground vehicles, helicopters and fixed wing aircraft from daytime into nighttime, with a 24 hour readiness covering even bad weather conditions. The visual aids fall into two physical categories: the image intensifiers, which amplify reflected residual light in the near infrared and the thermal imager, which detect the thermal radiation of all bodies mainly in the 8 to 12 micrometer atmospheric window for bodies with T approx. 20 C. During the last five years, the investigator has carried out helicopter flight trials at night using examples of all these visionic aids (FLIR, LLLTV, NVG, HMS/D and Direct View Optics) for piloting and observation tasks. The detection, recognition and identification range of nine different FLIR were tested in ground and laboratory tests. The evaluation of an optical sensor platform location in the helicopter nose-, roof- and mast-mounted versions, the comparison of thermal and intensifier images and the NVG compatible cockpit were topics of the tests. The optical sensors are described with their limitations and some results of the trials are given, with regard to the pilot's stress situation and eye safety. Author

N86-26811# Marconi Avionics Ltd., Rochester (England). Airborne Display Div.
NIGHT VISION BY NVG WITH FLIR
G. C. BULL *In* AGARD Visual Protection and Enhancement 7 p Dec. 1985
Avail: NTIS HC A11/MF A01

Night Vision Goggles and fixed forward looking infrared equipment both have particular operational shortcomings when used in a fixed wing aircraft for close air support at night. However, when operated together, they compensate for each others deficiencies forming a highly capable system at far less cost and complexity compared with other night vision systems. Author

N86-27473# Columbia Univ., New York. Dept. of Civil Engineering.
NOISE TRANSMISSION INTO PROPELLER AIRCRAFT Monthly Report
R. VAICAITIS *In* Shock and Vibration Information Center(Defense), The Shock and Vibration Digest, Volume 17, No. 8 , p 15-20 Aug. 1985
Avail: SVIC, Code 5804, Naval Research Lab., Washington, D.C. 20375 CSCL 20K

Papers and reports, most of which were written since 1981, that are concerned with airborne and structure-borne noise

transmission into a propeller-driven aircraft are surveyed. Special attention is given to a new propfan aircraft. Author

N86-27969# Federal Aviation Administration, Washington, D.C.
ADVISORY CIRCULAR: ESTIMATED AIRPLANE NOISE LEVELS IN A-WEIGHTED DECIBELS
27 Mar. 1986 38 p
(AC-36-3D) Avail: NTIS HC A03/MF A01

Federal Aviation Regulation (FAR) Part 36 requires the reporting of turbojet and large transport category aircraft certificated noise levels in units of Effective Perceived Noise Level in decibels. Many airport and other community noise analyses utilize a noise rating scale that is based upon A-weighted decibels. For this reason, A-weighted noise levels for aircraft under FAR Part 36 conditions were estimated to provide a reference source for aircraft noise levels that is consistent with the many noise rating scales having A-weighted noise level as the basic measurement. Listings of estimated aircraft noise levels in units of A-weighted sound level in decibels, ranked in descending order are presented. This information is provided both for aircraft that were noise type certificated under FAR Part 36 and for aircraft for which no such requirement currently exists. Author

N86-27970*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
SPECTRA OF NOISE AND AMPLIFIED TURBULENCE EMANATING FROM SHOCK-TURBULENCE INTERACTION: TWO SCENARIOS
H. S. RIBNER Mar. 1986 40 p Sponsored by the Natural Sciences and Engineering Research Council of Canada Prepared in cooperation with Toronto Univ. (Ontario)
(NASA-TM-88766; NAS 1.15:88766; UTIAS-TN-260; ISSN-0082-5263) Avail: NTIS HC A03/MF A01 CSCL 20A

This work is a small extension of NACA studies of the early fifties that predicted amplification of turbulence on passing through a shock wave (observed for turbulent boundary layers), as well as the generation of intense noise (observed for supersonic jets). The first solved the basic gasdynamics problem of the interaction of an infinite planar shock with a single three-dimensional spectrum component of turbulence (an oblique sinusoidal shear wave). The second developed the comprehensive 3D spectrum analysis necessary to generalize the scenario to the interaction of a shock wave with convected homogeneous turbulence. Numerical calculations were carried out to yield curves (vs. Mach number) of rms sound pressure, temperature fluctuation, and two components of turbulent velocity downstream of the shock, for two cases of preshock turbulence. The present numerical study reproduces these for one case and provides in addition their one-dimensional power spectra (vs. wavenumber or frequency). Ratios of the several postshock spectra to the longitudinal preshock turbulence spectrum (1D) have been computed for a wide range of Mach numbers; curves vs. wavenumber are presented for two scenarios of preshock turbulence: isotropy and axisymmetry, both based on the von Karman 3D spectrum. Author

N86-27972# Federal Aviation Administration, Washington, D.C. Office of Environment and Energy.
ANALYSIS OF HELICOPTER NOISE DATA USING INTERNATIONAL HELICOPTER NOISE CERTIFICATION PROCEDURES
J. S. NEWMAN, E. J. RICKLEY, D. A. LEVANDUSKI, and S. B. WOOLRIDGE Mar. 1986 282 p Prepared in cooperation with Operations Research, Inc., Rockville, Md.
(PB86-186533; FAA-EE-86-01) Avail: NTIS HC A13/MF A01 CSCL 20A

The results of a Federal Aviation Administration (FAA) noise measurement flight test program involving seven helicopters are documented. Noise levels were established using the basic testing, reduction and analysis techniques specified by the International Civil Aviation Organization (ICAO) for helicopter noise certification, supplemented with some procedural refinements contained in ICAO Working Group II recommendations for incorporation into the standard. GRA

17

SOCIAL SCIENCES

Includes social sciences (general); administration and management; documentation and information science; economics and cost analysis; law and political science; and urban technology and transportation.

A86-38308
DEVELOPMENTS IN AIRWORTHINESS CONTROL FOR CANADIAN AIRLINES
J. F. HAINES (Air Canada, Montreal) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 6 p.
(SAE PAPER 851784)

Changes in the control of aeronautics in Canada are discussed. The objectives and capabilities of the continuous maintenance system and the design approval representative system are described. The development of and requirements for the maintenance development program, which contains quality and engineering organizations, and an approved airworthiness engineering organization are examined. I.F.

A86-38317
AIRCRAFT GROUND SUPPORT EQUIPMENT STANDARDIZATION - THE PROS AND CONS OF 'FUNCTIONAL' VS 'TECHNICAL' STANDARDIZATION
J. J. MACHON (Air France, Paris) SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 14-17, 1985. 14 p.
(SAE PAPER 851794)

The main international bodies currently active in the fields of aircraft Ground Support Equipment (GSE) standardization are discussed, and an attempt is made to define what standardization should or should not be in this field. The activities of the ISO, SAE, and IATA are described, and their interlinks are shown. The classes of 'technical' standardization, which concerns design type specifications and purchasing type specifications, are addressed. The meaning of 'functional' specification, and how in practice it leads to a fairly effective worldwide GSE standardization, is considered. The way in which the market may respond to technical and functional standardization is discussed. C.D.

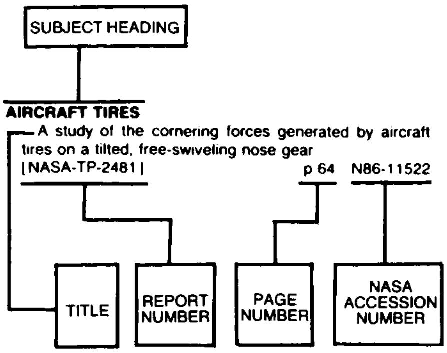
19

GENERAL

A86-39984
INVESTIGATIONS IN THE HISTORY AND THEORY OF THE DEVELOPMENT OF AVIATION AND SPACE SCIENCE AND TECHNOLOGY. NUMBER 4 [ISSLEDOVANIIA PO ISTORII I TEORII RAZVITIIA AVIATSIONNOI I RAKETNO-KOSMICHESKOI NAUKI I TEKHNIKI. NUMBER 4]
B. V. RAUSHENBAKH, ED. Moscow, Izdatel'stvo Nauka, 1985, 256 p. In Russian. No individual items are abstracted in this volume.

Papers on three main topics are presented. The first topic is a review of the history of the first 25 years of Soviet space flight. The second topic is a consideration of the history and development of aviation science and technology, with particular emphasis on aircraft design. The third topic is the Soviet manned space flight program during 1961-1981, with particular emphasis on the development of solid rocket engines. B.J.

Typical Subject Index Listing



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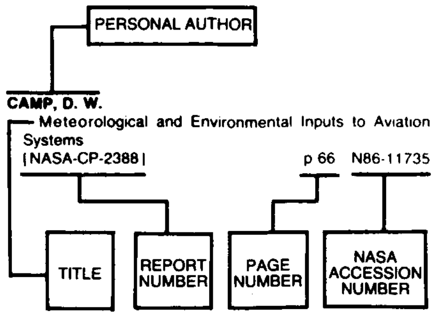

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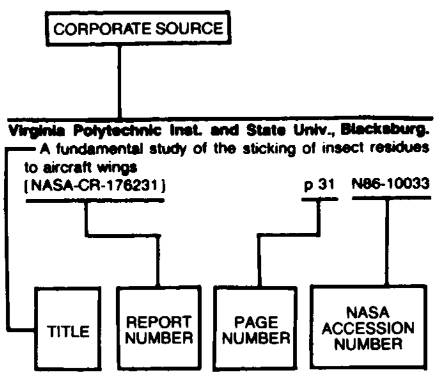

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A

B

C

D

Analyzing the cost effectiveness of using flight simulators in the Israeli Air Force
| AD-A164864 | p 599 N86-26346

Naval Ship Research and Development Center, Annapolis, Md.
Preliminary evaluation of a compound cycle engine for shipboard gensets
| NASA-CR-179451 | p 611 N86-26629

Nielsen Engineering and Research, Inc., Mountain View, Calif.
Unsteady forces on counter-rotating propeller blades
| AIAA PAPER 86-1804 | p 590 A86-37827

North Carolina State Univ., Raleigh.
Unsteady transonic flows past airfoils using the Euler equations
| AIAA PAPER 86-1764 | p 541 A86-37802
A three-dimensional boundary-layer method for flow over delta wings with leading-edge separation
| SAE PAPER 851818 | p 547 A86-38327
Linear dynamic coupling in geared rotor systems
| ASME PAPER 85-DET-11 | p 608 A86-38617
A direct and inverse boundary layer method for subsonic flow over delta wings p 557 N86-27195

Notre Dame Univ., Ind.
Experimental determination of the laminar separation bubble characteristics on an airfoil at low Reynolds numbers
| AIAA PAPER 86-1065 | p 548 A86-38433
Proceedings of the Conference on Low Reynolds Number Airfoil Aerodynamics
| NASA-CR-177308 | p 540 N86-26283
An experimental investigation of vortex breakdown on a delta wing p 557 N86-27196

O

Office National d'Etudes et de Recherches Aeronautiques, Paris (France).
Study of the transition behavior of an airplane in the vicinity of bifurcation points p 566 N86-27266

Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
La recherche aerospatiale. Bimonthly bulletin, no. 1984-6, November - December 1984
| ESA-TT-907 | p 559 N86-27217
A vortex point method for calculating inviscid incompressible flows around rotary wings
p 612 N86-27219
Dynamic stall modeling of the NACA 0012 profile
p 559 N86-27222
Helicopter noise p 560 N86-27223

Ohio State Univ., Columbus.
Investigations of transonic trailing edge flows
p 541 A86-37192
Simulation and analysis of antennas radiating in a complex environment p 572 A86-39535

Old Dominion Univ., Norfolk, Va.
Influence of numerical dissipation in computing supersonic vortex-dominated flows
| AIAA PAPER 86-1073 | p 549 A86-38439
Effects of nonlinear damping on random response of beams to acoustic loading
| AIAA PAPER 86-1004 | p 609 A86-38945

Operations Research, Inc., Rockville, Md.
Analysis of helicopter noise data using international helicopter noise certification procedures
| PB86-186533 | p 620 N86-27972

P

Pratt and Whitney Aircraft, East Hartford, Conn.
Structural tailoring of engine blades (STAEBL) theoretical manual
| NASA-CR-175112 | p 592 N86-27283
Structural tailoring of engine blades (STAEBL) user's manual
| NASA-CR-175113 | p 592 N86-27284

PRC Kentron, Inc., Hampton, Va.
NASA experiments onboard the controlled impact demonstration
| SAE PAPER 851885 | p 568 A86-38352
Structural analysis of the controlled impact demonstration of a jet transport airplane
| AIAA PAPER 86-0939 | p 583 A86-38836
Integrated aeroservoelastic tailoring of lifting surfaces
| AIAA PAPER 86-1005 | p 594 A86-38946
Effect of emerging technology on a convertible, business/interceptor, supersonic-cruise jet
| NASA-CR-178097 | p 587 N86-27278

Princeton Univ., N. J.
A demonstration expert system for implementing emergency procedures in a high-performance fighter aircraft
| MAE-1749 | p 569 N86-26295

Integrated risk/cost planning models for the US Air Traffic system
| NASA-CR-177274 | p 573 N86-26312
An optimization model for the US Air-Traffic System
| NASA-CR-177277 | p 574 N86-27271

Purdue Univ., West Lafayette, Ind.
Unsteady forces on counter-rotating propeller blades
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Passive control of aerodynamically forced vibrations of supersonic turbomachine rotors by splitter blades
| AIAA PAPER 86-0844 | p 590 A86-38892
Three dimensional unsteady aerodynamics and aeroelastic response of advanced turboprops
| AIAA PAPER 86-0846 | p 591 A86-38894
Nonisentropic unsteady three dimensional small disturbance potential theory
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A computational transonic flutter boundary tracking procedure
| AIAA PAPER 86-0902 | p 553 A86-38913
Integrated aeroservoelastic tailoring of lifting surfaces
| AIAA PAPER 86-1005 | p 594 A86-38946
Frequency domain synthesis of a robust flutter suppression control law p 594 A86-39042

R

Radio Technical Commission for Aeronautics, Washington, D. C.
Minimum operational performance standards for airborne thunderstorm detection equipment
| RTCA/DO-191 | p 617 N86-27851

Rockwell International Corp., Downey, Calif.
Operational flight experience and disassembly/inspection results of Space Shuttle orbiter actuators p 600 N86-27354

Rolls-Royce Ltd., Derby (England).
Design, development and operation of a high simultaneous capacity digital telemetry system
p 613 N86-27632

Royal Aircraft Establishment, Bedford (England).
New rotary rig at RAE and experiments on HIRM
p 562 N86-27243

Royal Aircraft Establishment, Farnborough (England).
Correlation of predicted and free-flight responses near departure conditions of a high incidence research model
p 564 N86-27255

Royal Netherlands Aircraft Factories Fokker, Amsterdam.
Principles and applications of the Fokker bond tester
| ESA-86-96960 | p 612 N86-27624

S

SASC Technologies, Inc., Hampton, Va.
Numerical simulation of precipitation induced downbursts p 615 A86-37496

Science Applications International Corp., Princeton, N.J.
Progress in the development of parabolized Navier-Stokes (PNS) methodology for analyzing propulsive jet mixing problems
| AIAA PAPER 86-1115 | p 551 A86-38473

Sherbrooke Univ. (Quebec).
Experimental study of the effect of turbulence on dynamic stalling p 565 N86-27264

Shock and Vibration Information Center (Defense), Washington, D. C.
The Shock and Vibration Digest, volume 18, no. 1
| AD-A165726 | p 612 N86-27468
The Shock and Vibration Digest, volume 17, no. 8
| AD-A165115 | p 612 N86-27471

Simula, Inc., Phoenix, Ariz.
Crash-resistant crewseat limit-load optimization through dynamic testing with cadavers
| AD-A164828 | p 569 N86-26298

Smith Associates Consulting System Engineers Ltd., Cobham (England).
A self-organising control system for non-linear aircraft dynamics p 564 N86-27258

Societe Francaise d'Instruments de Mesure, Velizy-Villacoublay (France).
Use of a CO2 laser lidar for flight and penetration at very low altitudes p 610 N86-26326

Southwest Research Inst., San Antonio, Tex.
High-temperature lubrication systems for ring/liner applications in advanced heat engines
| AD-A164955 | p 604 N86-26446

Spectra Technology, Inc., Bellevue, Wash.
Experiments on supersonic turbulent flow development in a square duct
| AIAA PAPER 86-1038 | p 548 A86-38412

Stanford Univ., Calif.
Aeroelastic tailoring of composite wings with external stores
| AIAA PAPER 86-1021 | p 609 A86-38878

Sverdrup Technology, Inc., Cleveland, Ohio.
Calibration of droplet sizing and liquid water content instruments: Survey and analysis
| NASA-CR-175099 | p 611 N86-26596

T

Technische Hogeschool, Delft (Netherlands).
Effects of aerodynamic lags on aircraft responses
p 564 N86-27257

Texas A&M Univ., College Station.
An investigation of the effects of the propeller slipstream of a laminar wing boundary layer
| SAE PAPER 850859 | p 551 A86-38502

Textron Bell Helicopter, Fort Worth, Tex.
Six degree-of-freedom LIVE isolation systems, part 1
| NASA-CR-177928 | p 587 N86-26331

Theory and Applications Unlimited Corp., Los Gatos, Calif.
A new technique for terrain following/terrain avoidance guidance command generation p 574 N86-26325

Thomson-CSF, Issy les Moulineaux (France).
Synthetic real-time relief display all-weather airborne missions p 589 N86-26321

Toronto Univ. (Ontario).
Flight simulation motion-base drive algorithms. Part 2: Selecting the system parameters
| UTIAS-307 | p 618 N86-27929
Spectra of noise and amplified turbulence emanating from shock-turbulence interaction: Two scenarios
| NASA-TM-88766 | p 620 N86-27970

U

United Technologies Corp., East Hartford, Conn.
Three-dimensional inviscid flow in mixers. I - Mixer analysis using a Cartesian grid p 554 A86-39090

United Technologies Research Center, East Hartford, Conn.
Three-dimensional inviscid flow in mixers. I - Mixer analysis using a Cartesian grid p 554 A86-39090
Analysis of transitional separation bubbles on infinite swept wings
| NASA-CR-3956 | p 555 N86-26288
Dynamic stall of swept and unswept oscillating wings
p 560 N86-27226

V

Vigyan Research Associates, Inc., Hampton, Va.
Swept wing-tip shapes for low-speed airplanes
| SAE PAPER 851770 | p 546 A86-38305
Basic studies on delta wing flow modifications by means of apex fences p 557 N86-27199
Towards an advanced vortex flap system: The cavity flap p 557 N86-27200

Virginia Polytechnic Inst. and State Univ., Blacksburg.
Linear dynamic coupling in geared rotor systems
| ASME PAPER 85-DET-11 | p 608 A86-38617
Application of the unsteady vortex-lattice method to the nonlinear two-degree-of-freedom aeroelastic equations
| AIAA PAPER 86-0867 | p 585 A86-38902
Thermodynamic evaluation of transonic compressor rotors using the finite volume approach
| NASA-CR-176840 | p 610 N86-26546

Vrije Universiteit, Brussels (Belgium).
Velocity and turbulence measurements in dynamically stalled boundary layers on an oscillating airfoil
p 560 N86-27228

W

Washington Univ., Seattle.
Experiments on supersonic turbulent flow development in a square duct
| AIAA PAPER 86-1038 | p 548 A86-38412
Use of NDE to evaluate reflection cracking in airfield pavements
| AD-A164880 | p 599 N86-27293

Wear Sciences, Inc., Arnold, Md.
High-temperature lubrication systems for ring/liner applications in advanced heat engines
| AD-A164955 | p 604 N86-26446

Westland Helicopters Ltd., Yeovil (England).
Unsteady aerodynamics application to helicopter noise and vibration sources p 562 N86-27241

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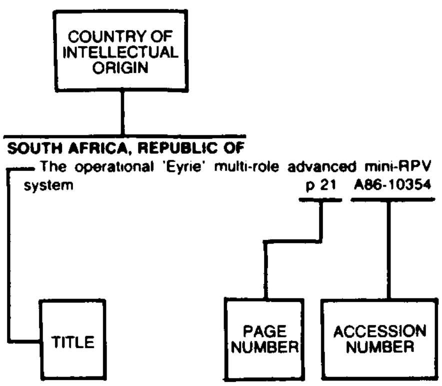

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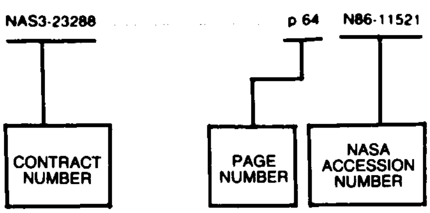

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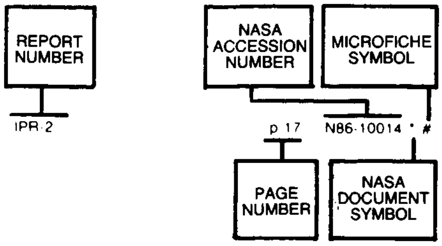

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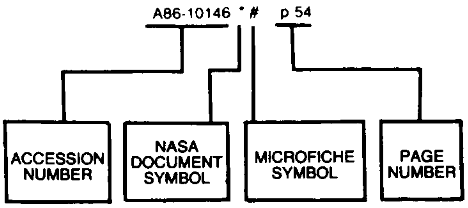

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